SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, MAY 3, 1901.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

HENRY AUGUSTUS ROWLAND.

IN the death of Professor Rowland, at the age of fifty-three, in the fulness of his activity and powers, the world has lost one of its foremost men of genius; America, its greatest scientist; Johns Hopkins University, the teacher and investigator who has brought it most renown.

Henry Augustus Rowland was born at Honesdale, Pennsylvania, Nov. 27, 1848; he entered the Rensselaer Polytechnic Institute, Troy, and received the degree of C.E. in 1870. After a brief experience in practical engineering on a railroad he accepted the position of teacher of science in Wooster College, where he taught physics, zoology and geology for the year 1871–2. He was then called to the Rensselaer Institute as instructor, and was soon promoted to assistant professor. He remained at Troy until he accepted a position at Johns Hopkins University in 1875. The attention of President Gilman of Johns Hopkins University was directed to Rowland by Professor Michie of West Point; and the first meeting of the two took place at the Academy on the Hudson. Before assuming the duties of his new office, at the suggestion of President Gilman, he spent a year in Europe purchasing apparatus for his laboratory, becoming acquainted with the prominent scientists of England and the Continent, and making a prolonged

stay in Berlin in order to carry out in Helmholtz's laboratory an investigation which he had long contemplated. He returned to America in 1876, was made professor of physics at Johns Hopkins, and at once began his work. His influence was immediately felt not alone in the University, but throughout the whole country; and students came from both North and South to receive inspiration and guidance. As research after research, discovery after discovery, was made, honors came from both home and abroad; his reputation and renown increased until in the whole country there was no one whose influence in all fields of scientific study or application was so great. It was in Baltimore that nearly all his great work was done, and it was here that he died on the 16th of April.

Professor Rowland was honored by being elected a member of many scientific bodies. He was Honorary Member of the Royal Society of London; Honorary Member of the Royal Society of Edinburgh; Honorary Member of the Royal Academy of Sciences, Berlin; Corresponding Member of the Royal Society of Göttingen; Corresponding Member of the Academy of Sciences of Paris; Honorary Member of the Cambridge Philosophical Society; Honorary Member of the Physical Society of London; Foreign Member of the Royal Swedish Academy of Stockholm; Associate Fellow of the American Academy of Arts and Sciences; Member of the National Academy of Sciences, and a member of nine other learned societies.

He was awarded the Rumford Medal by the American Academy in 1884, the Matteucci Medal in 1897, and received medals at the Exhibitions of Chicago and Paris. He received the honorary degrees of Ph.D. from Johns Hopkins in 1880 and of LL.D. from Yale in 1895 and Princeton in 1896. He was made an officer of the Legion of Honor in 1896.

Even as a young man, Rowland was occupied continually with problems and questions pertaining to chemical and physical science; he had his own laboratory and workshop in which he performed experiments and constructed apparatus. He read the works of Faraday and others and made their subject-matter thoroughly his own. His note-books kept when he was still a youth are full of most remarkable conjectures as to the undiscovered truths of nature, of proposed experiments, of most discriminating and accurate observations, and of many interesting theoretical discussions. It is to be earnestly hoped that the contents of these books will some day be published.

It is hardly necessary to give more than a summary of his most important researches. While at Troy he made those investigations on magnetic induction, permeability and distribution, which at once attracted the attention of Clerk-Maxwell. In Berlin he carried out his experiments on electric convection, which proved that an electrostatic charge carried at a high rate of speed has the same magnetic action as an electric current. (The results of this experiment have recently been called in question; but a repetition of the work during the past winter has confirmed them.) His first important piece of work in Baltimore was the determination of the mechanical equivalent of heat, which necessitated more careful thermometric and calorimetric methods than had ever been used before. He then became interested in questions dealing with electricity and, realizing the importance of accuracy in the measurement of electrical quantities, made a most careful determination of the ohm. This work was repeated and extended later, at the request of the United States Government.

The great problem of the connection between ether and matter was always before him, and in the desire of adding some-

thing to our knowledge he devised many experiments which were carried out by his students under his immediate direction; of these the most important were the one performed by Professor Hall, which led to the discovery of the 'Hall effect,' and those recently performed by Dr. Gilbert, which have led to purely negative results. Becoming interested in the study of spectrum analysis, largely through the influence of his colleague Professor Hastings, he realized the importance of securing as perfect gratings as possible. So he constructed a dividing engine for the ruling of gratings, the essential parts of which were a screw of nearly perfect uniformity of pitch and a most ingenious device for the correction of periodic errors. With this machine many gratings were ruled on both glass and speculum metal, the surfaces being plane. But the idea occurred to him to investigate the action of a grating ruled on a spherical concave surface; he discussed the question mathematically and thus discovered the great advantages of such 'concave gratings,' and proceeded at once to rule them. (It should be noted that all the gratings, both plane and concave, which have been ruled under Professor Rowland's direction and are now in use in all the physical laboratories of the world, have been sold at such prices as simply paid the wages of the laboratory mechanician who supervised their construction.) With these gratings the study of the solar spectrum was begun; and in order to supplement eye-observations, he made a careful study of photographic methods, and prepared his own photographic plates. Having mapped the whole solar spectrum from the extreme red to the limits in the ultra violet, he had enlarged maps prepared and offered to the world. Then he undertook the systematic study of the arc-spectra of all the elements, so far as possible; and the final results of this long research are now nearly ready for publication. Within recent years his attention had been called to the theory of alternating currents and to their application for practical purposes. He devised a system of multiplex telegraphy depending upon synchronous motors, which received a grand medal at the Paris Exposition of 1900.

These are but the most important of Rowland's contributions to science; a complete list would be even more striking. Far more important, however, than the results of the investigations themselves, is the spirit, the aim of the man as made manifest in them. His great purpose was to discover not simply the truth in nature, but the deeply hidden truth. Questions pertaining to the *fundamental* properties of electricity, magnetism, ether and matter were always in his mind; the exact measurement of spectrum lines was interesting to him only in so far as the results might lead to accurate knowledge of molecular constitution or of solar and stellar phenomena; all instruments or methods perfected by him were those which could be used to measure the *great* constants of nature.

To appreciate properly Rowland's greatness as an investigator one must have worked with him. He enjoyed to the utmost the rare gifts of intuitive knowledge and of self-confidence. His energy, his manual dexterity, his ingenuity, his keenness in perceiving and avoiding experimental errors, his skill in devising apparatus, were always evident. No scientist of this generation has had greater power than he of using his imagination under the restraints and guidance of scientific knowledge.

As the director of a great physical laboratory, Rowland was in some ways unique. His enthusiasm and the inspiration of his example were always of the greatest help; his suggestions were invaluable; but his critical powers, his deep insight into any

physical problem, his searching questions were the qualities of untold benefit. He rarely delivered a lecture without calling attention to some subject which needed experimental study; he was never present at a meeting where scientific papers were read or discussed without pointing out some error or possible improvement in the method of experimenting. He was rarely on intimate terms with his students; but no one came near him without recognizing his sweetness of character, his entire freedom from petty faults, his absolute unswerving devotion to the pursuit of truth.

J. S. AMES.

JOHNS HOPKINS UNIVERSITY.

IMMUNITY AND PROTECTIVE INOCULATION.*

"When we search the history of the development of scientific truth we learn that no new fact or achievement ever stands by itself, no new discovery ever leaps forth in perfect panoply, as Minerva did from the brow of Jove.

"Absolute originality does not exist, and a new discovery is largely the product of what has gone before.

"We may be confident that each forward step is not ordered by one individual alone, but is also the outcome in a large measure of the labors of others. The history of scientific effort tells us that the past is not something to look back upon with regret—something lost, never to be recalled—but rather as an abiding influence helping us to accomplish yet greater successes."—Sir Michael Foster.

"Again and again we may read in the words of some half-forgotten worthy the outlines of an idea which has shone forth in later days as an acknowledged truth."—Sir William MacCormac.

THE fact that persons once afflicted with smallpox rarely experienced a second attack of that disease when repeatedly exposed to it was not only early observed, but made a matter of record by the Chinese long before the beginning of the Christian era. That the disease was contagious had long been a matter of common experience, and the means of protection against its ravages early became an interesting subject for investigation.

The Chinese observed that when the dried and pulverized material from smallpox pustules was blown into the nostrils of persons who had not experienced an attack of the disease, the disease in persons thus infected underwent a milder course, was accompanied by a lower death rate, and conferred immunity against further attacks of smallpox. This early method of protection against the ravages of the disease became a common custom in China and India; but was later superseded by a more direct method of inoculation, that of introducing beneath the skin the scab of variolus pustules. The Chinese used the dried scab, the ordinary Hindoos the fluid pus, and the Brahmans pus that had been kept in wool for a period of twelve months. The last is clearly an instance of using attenuated virus.

It should be remembered that smallpox extended westward to Europe during the sixth century, that it reached England toward the close of the ninth century, and at the time of the Crusades became widespread. In 1517 it was carried from Europe to Santo Domingo; reached Mexico in 1520, whence it spread throughout the New World. It was introduced into Iceland in 1707 and to Greenland in 1733.

It should be particularly noted, that in the invasion of new territory the virulence of smallpox at once became greatly intensified—in some instances nearly one-half the population being destroyed by it. Robertson records the death of three million and a half of people in Mexico alone as the result of the invasion of 1520. Again, the dark-colored races seem to be more easily infected than Europeans.

The protective method of directly inoculating the pulverized variolus scab beneath the skin slowly traveled westward; so

* Address of the President of the Texas Academy of Science, given in the Chemical Theater of the University of Texas, on October 26, 1900.

slowly, that it did not reach Western Europe until 1718, when Lady Mary Wortley Montagu introduced the process then in vogue in Constantinople. While the year 1718 marks the introduction of protective inoculation to the aristocracy of England, the practice had come into use among Scotch and Welsh peasants at a much earlier date, which probably accounts for the next stage in the evolution of measures of protection against infectious diseases.

Herdsmen and milkmaids in both England and Schleswig-Holstein observed that occasionally on the udder of cows there appeared an eruption resembling smallpox; that this eruption could be communicated to persons engaged in milking; and that persons infected with the cowpox were protected against an invasion of true smallpox. The fact that the notorious Mrs. Palmer, Duchess of Cleveland, was thus protected is evidence sufficient to show that such observations were common as early as 1663. In 1768 Fewster and Sutton in London; 1774, Jesty, a Dorsetshire farmer; 1791, Pless, a Holstein teacher, and May 14, 1796, Jenner, confirmed these observations. It is true that the immortal work of Jenner began as early as the year 1769; for at this time, while a student under John Hunter, he heard a young country woman, in whose presence the subject of smallpox was mentioned, say: "I cannot take that disease, for I have had cowpox." Upon mentioning the subject to his master, Hunter replied "*Do not think, but try; be patient, be accurate.*" Jenner did try; was patient, was accurate; and on May 14, 1796, after years of patient labor, in his 'Inquiry into the Causes and Effects of the Variolæ Vaccinæ,' he experimentally established the following facts:

1. That this disease (cowpox) casually communicated to man has the power of rendering him unsusceptible of smallpox.

2. That the specific cowpox alone, and not other eruptions affecting the cow, which might be confounded with it, had this protective power.

3. That the cowpox might be communicated at will from the cow to man by the hand of the surgeon, whenever the requisite opportunity existed. And

4. That the cowpox once ingrafted on the human subject, might be continued from individual to individual by successive transmissions, conferring on each the same immunity from smallpox as was enjoyed by the one first infected direct from the cow.

Thus it is seen that Jenner, by inoculating a cow with variolus matter produced in the cow an eruptive disease resembling smallpox, but of a milder type, and that the cultivation of this milder disease in the cow yielded a fixed virus (vaccine) which, transplanted to man, gave rise to a still milder eruptive disease (vaccinia) possessing constant characteristics, and conferring upon persons who underwent it immunity against smallpox.

The older methods of inoculation against smallpox were quickly supplanted by the simpler and far safer method of vaccination; and since the introduction of the latter the appalling ravages of smallpox have been relegated to historical literature.

The subsequent development of vaccination is a matter of such general information that there is no need of its further discussion here. It is sufficient to say that in the great majority (if not in all) of the cases of successful vaccination immunity against smallpox is conferred for an indefinite period, varying from three years to many years—averaging three to seven years—in some cases for life; and that compulsory vaccination and revaccination offer the safest and surest protection against this loathsome disease.

The success of vaccination gave great impetus to the investigation of the problem of immunity, and the annals of the nineteenth century contain a voluminous record of the prolonged and patient efforts of a host of brilliant workers whose contributions have at least laid the foundation upon which the

solution of the problem may, in the future, be built. The building of this foundation can not be recounted here; but it will be necessary to mention some of the materials of which it is made, that the latest progress may be intelligently discussed.

As in the case of smallpox, it had long been a matter of common observation that a number of the acute infectious diseases occur but once in the same individual. Whooping-cough, measles, scarlet-fever and yellow-fever are notable examples of acute infectious diseases one attack of which usually confers immunity against subsequent attacks of the same disease. It was also observed that some infectious diseases confer a very evanescent type of immunity, and that others confer no immunity whatever.

From the standpoint of immunity the infectious diseases may be easily divided into three classes:

1. Diseases one attack of which confers immunity against subsequent attacks of the same disease.

2. Diseases one attack of which confers immunity against subsequent attacks of the same disease for only short periods of time.

3. Diseases an attack of which confers no immunity whatever.

It would seem that these facts, coupled with Jenner's discovery of a fundamental and practical method of producing artificial immunity, clearly outlined the path for future workers to follow; but, strange to say, the nineteenth century was well on its way before this important route found many followers.

The failure to appreciate fully Jenner's brilliant discovery, and to apply his method to the study of other infectious diseases, finds an explanation in the hazy theoretical conceptions of the cause and nature of infectious diseases which prevailed during the early part of the century. The investigations of fermentation by Astier, Sette, Franz Schulze, Cagnaird de Latour, Schwann, Fuchs, Remak, Mitscherlich, Helmholtz and others did much toward clearing the haziness of that period; but it was the monumental work of Pasteur that 'finally established the truth of the view that all processes of fermentation and putrefaction alike are caused by living things, and that in each different fermentation different kinds of microbes are concerned.' In the light of newer knowledge this statement needs revision. The investigations of Koch on anthrax soon followed, and then came the growth of pure cultures of several pathogenic bacteria.

"The work of Pasteur and Koch afforded the first basis on which the study of artificial immunity could be again undertaken. The possibility of voluntarily producing a number of the most important infectious diseases of men and animals, and of modifying at will pure cultivations of bacteria, either, according to Jenner's precedent, by passage through the animal body, or otherwise on artificial culture media, laid the foundation on which advancement could proceed. Pasteur himself was the first, after Jenner, to produce an artificial immunity by using an attenuated virus; and he was also able to introduce the procedure to some extent into practice with most beneficial results. Still the theoretical explanation of all these facts lagged far behind their practical effects. The very able investigations of Metschnikoff and his theory of phagocytosis were, to many investigators, inconclusive."

Numerous attempts were made to formulate adequate theoretical explanations of the accumulated facts concerning the phenomena of infectious diseases. The followers of Sydenham looked upon the specific disease itself as an *entity;* while Lotze and Virchow viewed it as a *process.* It was clear that a mechanical or dynamical process could not be a living entity. The

physiologists Haller, Reil and Johannes Müller had established this principle for normal life processes, and its extension to abnormal life processes was simple enough. "Whatever be the outside forces that act, the eye perceives only light, and the ear only sound; the glands simply secrete and the muscles contract. It is, therefore, the internal condition of the organism, of its organs, tissues or cells, that alone determines the character of the effect. The impulse that must come from the outside to produce these effects is called the stimulus. Hence there must exist a fundamental internal organization, that is to say, a predisposition to something external. * * * Disease, then, may be regarded as the effect produced by quantitative changes in normal conditions, either when the physiological organization is too feeble or the stimulus too intense." Disease may be viewed as a phenomenon of adaptation.

Against this conception, the parasitic or germ theory, developed by Plenciz, Eisenmann, Henle, Davaine, Pasteur, Klebs, F. Cohn, J. Schröter and Koch, appeared to introduce an entirely new qualitative element. It asserts 'that many diseases are due to the presence and propagation in the system of minute organisms having no part or share in its normal economy.'

Another conception is that of Pettenkofer, which holds that the determining cause is to be found in the external conditions, which vary according to time and place.

It is not difficult to see that these theories are upholding entities as the cause of disease. While a kernel of truth is to be found in each, they all fail to realize the continuity of causes in the sense of modern exact science. "The true and sufficient cause of any effect is always something internal, something that follows from the kind and amount of initial energy, and from that quality and quantity alone and entirely. * * * It is the absolute thing 'that exists behind all change and remains primordially the same,' as Helmholtz expressed it." Or as the modern physicist would put it: potential energy = cause, kinetic energy = effect; and as a liberating impulse will change potential energy into kinetic energy, so a liberating impulse will change cause into effect.

The cloudiness that characterizes many of the theories that have sought to explain the phenomena of infectious diseases is largely a legacy of Kantism, and is clearly out of place in these days of modern science. It is somewhat strange that 'ontological toys' are still to be found in the workshop of some really brilliant investigators of natural phenomena. Nevertheless, they are there —which explains some explanations that do not explain.

The parallelism which subsists between the phenomena of fermentation, infection and immunity, suggests the mental route to be traveled if an insight into our problem is to be gained; and for this reason it is necessary to first point out a few facts about fermentation.

FERMENTATION.

If the phenomena of matter be defined as periodic functions of the atomic and molecular masses which constitute it and the rates of motion of these masses, and the chemical unit be viewed as a 'center through which energy manifests itself,' then the theories of modern chemistry should supply an explanation of the phenomena of fermentation.

The crucial test of every theory which seeks to explain fermentation is the satisfactory explanation of the following phenomena:

Enzymes appear to be capable of disrupting complex chemical bodies without undergoing any apparent chemical change themselves—that is, they bring about a

chemical change in disproportionately large quantities of material. When the newly produced substances attain a certain concentration the further action of the enzyme is inhibited, but its action is reasserted when the concentration of the zymolytic products is again lowered. Maximum, minimum and optimum temperature and pressure influence these changes. The introduction of certain chemical bodies also exerts an accelerating or retarding influence; and phenomena of *selective* action are likewise to be found.

Many hypotheses have been submitted. Very ingenious explanations of some of the phases of fermentation are to be found in them; but under the searching light of completer knowledge their incompleteness is sooner or later developed. Many of the modern theories are little else than translations of the earlier hypotheses into terms of modern scientific terminology, so that the later literature is laden with modern extensions of the catalytic theory of Berzelius, Beal's bioplastic theory, Justus von Liebig's physical theory, the germ theory, etc.

Interesting and enlightening as some of these theories are, their full consideration is not within the purpose of this address, the limits of which will permit only a brief and incomplete review of some of the more modern conceptions of fermentation, to which attention is now asked.

The more recent investigations of the organized and unorganized (soluble) ferments have dealt a severe blow to the vitalistic theory of fermentation. Hansen's admirable biological researches upon the yeasts, followed by the important investigations of Buchner, A. Croft Hill, Emil Fischer and many others brought to light many interesting hitherto hidden facts; and it now seems clear that all the phenomena of fermentation may be explained from a purely chemical basis. The so-called organized ferments appear to be 'active proteids,' and the unorganized ferments, or enzymes are mostly proteid-like bodies presenting great differences in the complexity of their chemical structure.

Hueppe looks upon 'active proteid' as "a kind of intermediate stage between lifeless 'nutritional' proteid and living cells"; that it 'appears like an anhydride of dead proteid,' inasmuch as hydration converts it into an inactive form. Investigations of Bokorny and Loew demonstrated the existence of active proteid in many plants. Loew speaks of it as reserve protein matter of a highly labile nature, and that it differs from all other reserve proteins. He called it proto-protein, and suggested that it is the 'material which, by being converted into organized nucleo-proteids, forms living matter.' Protein comprises all kinds of albuminous matter, while proteid is used to designate complex compounds of proteins, such as nucleins, hæmoglobin, etc. *Labile* chemical compounds are unstable bodies which easily undergo chemical change. Labile atoms or groups of atoms are atoms or groups of atoms which readily migrate from a center of instability to one of stability. When the migration is intramolecular a stereoisomeric compound is the product of change; when the migration is extra- or intermolecular disruption of the molecules takes place. Loew points out the necessity of distinguishing between 'potentially labile and kinetically labile compounds; in other words, between static labile and dynamic labile'—using the potential chemical energy in the sense of intramolecular chemical energy. Nitroglycerole and certain other explosive organic compounds represent the potential type, while examples of the kinetic are found in the aldehydes and ketones.

The energy stored in a labile compound is beautifully illustrated in the explosion of the trinitrate of glyceryl—$CH_2(ONO_2).CH$

$(ONO_2).CH_2(ONO_2)$, which when heated to 257° C., or when struck, explodes with great violence. The products of the decomposition are represented by the equation:

$$4C_3H_5.(NO_3)_3 \Rightarrow 12CO_2 + 10H_2O + 6N_2 + O_2.$$

At the temperature of the explosion all these products are gases, and at atmospheric pressure will now occupy the space of about 10,400 liters, having expanded about 18,324 times its original volume.

Another instance is that of mercury fulminate $[(C:N.O)_2Hg + \frac{1}{2}H_2O]$, which develops a pressure of 43,000 atmospheres by detonating in its own volume.

Chemical changes partially or completely destroy the statically labile compounds, while the dynamically labile compounds readily pass into isomeric or polymeric compounds as a result of atomic migrations, or by polymerization. The classic illustration usually given of the production of an isomeric compound produced by atomic migration is Wœhler's famous discovery: the transformation of ammonium cyanate into urea, which he accomplished in 1828, by evaporating an aqueous solution of ammonium isocyanate. The transformation is represented by the equation:

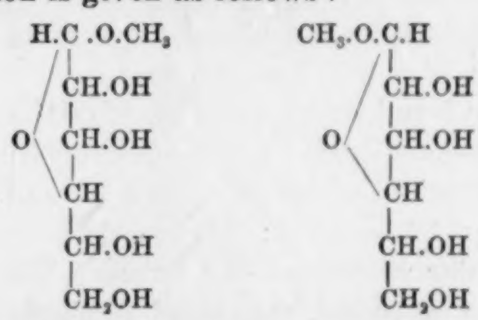
$$O:C:N.NH_4 \Rightarrow O:C<^{NH_2}_{NH_2}.$$

Many others can be cited.

Noting that labile compounds are more easily attacked by chemical agents than stable ones, Loew has elucidated the action of many poisons. He says: "A systematic toxicological review shows us among other things that all compounds acting upon aldehydes and all that easily attack labile amido-groups are poisonous for all kinds of living protoplasm, which fact led me to infer that the lability of the plasma proteids is caused by the presence of aldehyde and amido-groups within the same molecules. * * * The *primum movens* in the living protoplasm must be defined as a mode of motion of labile atoms in the plasma proteins; that is, as a *special case of chemical energy*." According to Loew, the enzymes belong to the dynamically labile compounds.

While the chemical structure of the enzymes is not yet known the researches of Emil Fischer go to show that a knowledge of their constitution is not far beyond our reach. In the fermentation of the sugars Fischer has shown that the enzymes can only 'attack those sugars which possess a molecular configuration corresponding to their own'—that is, they must fit each other 'as the key fits its lock.' Viewing the enzymes as nucleo-proteid bodies, and as being optically active, he reasoned that *their molecules must have an asymmetric structure.* Their selective action toward α and β methyl-glucosides strongly supports this view.

According to Fischer, two methyl-glucosides are formed by the action of hydrochloric acid (HCl) on a solution of *d* glucose in methyl alcohol, and their configuration is given as follows:



One is called α the other β, and their difference is found in the configuration of the one asymmetric carbon atom, yet the enzymes which attack the α will not attack the β, and *vice versa*. This important discovery sheds a world of light upon the vexed problem of fermentation, and will therefore help to explain many of the obscure phenomena of disease and of immunity. It will also find a place in the investigation of many of the difficult problems of physiological chemistry. A very admirable feature of Fischer's hypothesis is its capacity to receive aid

from, and give aid to, several other hypotheses—it possesses a wide range of applicability.

In 1892, our esteemed colleague, Professor J. W. McLaughlin, in his book on 'Fermentation, Infection and Immunity,' elaborated a 'Physical Theory,' a quotation from which is here presented. After developing the modern conception of complex molecules, Dr. McLaughlin goes on to say: "When we add to this conception of atomic and molecular union, that of atomic vibrations in unvarying periods of time which are distinctive of each kind of atom, and that of ethereal wave-motions vibrating in equal periods with the atoms that produce them, the law of 'interference' enables us to understand how atomic wave-motions may be supplemented or antagonized by other atomic wave-motions, and how molecular wave-motions may, likewise, be similarly influenced by other molecular waves; that, in fact, the molecular waves which give a substance its energy will vary with molecular grouping. Now it is in these principles of molecular dynamics, and in chemistry and biology, that, we believe, is to be found the explanation of cell metabolism—constructive and destructive—of fermentation, of infection and immunity." On page 66, he says: "It is only when the molecular vibrations of a ferment, whether this be a living, organized ferment, or a non-living, unorganized ferment, coincide with those of a fermentable substance, that the latter may be disrupted by the former, and fermentation ensue." While these two quotations do not adequately present Dr. McLaughlin's theory, they suggest a connecting link with the physical hypothesis of de Jager.

"Starting with Naegeli's view that fermenting yeast-cells emit vibrations which pass out of the cells and decompose the sugar in the solution surrounding them, de Jager suggests that the enzymes may be regarded not as substances at all, but as the vibrations themselves, that is as properties of substances rather than material bodies." He compares them to light, electricity, magnetism. Fermentation does not depend upon chemical action of a molecular substance, but chemical transformations are brought about by physical forces. Maurice Arthus has very ingeniously elaborated the theory of de Jager.

O'Sullivan and Tompson have shown that invertase is capable of inverting more than 100,000 times its own weight of cane sugar without exhausting itself; and Tamman proved that under proper conditions the enzyme is decomposed during its activity with extreme slowness. These reactions find their parallel in the action of nitric oxide in the manufacture of sulphuric acid, and in the action of sulphuric acid in the production of ethyl oxide; and Bredig and von Berneck have recently shown that "one gram-atom (193 grams) of colloidal platinum diffused through seventy million liters of water shows a perceptible action on more than a million times the quantity of hydrogen peroxide."

In these four instances it will be observed that the invertase, nitric oxide, sulphuric acid, and colloidal platinum acted solely in the capacity of catalyzers, that is, they modified the time factor of the reaction —the positive catalyzers accelerating, and the negative catalyzers retarding, the velocity of the reactions. Catalyzers, then, serve in the capacity of *liberating impulses*.

That zymohydrolysis is a chemical action finds further support in the recent work of A. Croft Hill on 'Reversible Zymohydrolysis.' By varying the concentration of mixtures of glucose and maltose he found that the equilibrium point of these two sugars was reached when 85.5% of glucose and 14.5% of maltose were present. Increasing the glucose beyond 85.5% sent the hydrolysis one way, and the reaction reversed

when the maltose was increased beyond 14.5%. This is in strict conformity with the law that "*every reaction proceeds to a state of equilibrium, with a definite reaction velocity.*"

The phenomena of reversible reactions have been well worked out, and Konowalow's reaction of acetic acid upon pentene:

$$CH_3CO.OH + C_5H_{10} \rightleftarrows CH_3CO.O(C_5H_{11}),$$

has been shown to conform to the requirements of the law of mass-action by Nernst and Hohmann.

Another very important observation made by Bredig and von Berneck is that "relatively minute portions of certain substances are able to inhibit the catalytic action of platinum, and that these are substances which exert a markedly poisonous effect on the living cell and on enzymes. 1/345,000 gram-molecule per liter of hydrogen sulphide already exerts a strongly restraining action. 1/1,000 gram-molecule per liter of hydrocyanic acid stops it entirely, and much less is able to retard it greatly. Carbon disulphide, and mercuric chloride show a similar behavior." This again parallels the action of ferments and antiferments.

Were it necessary, many other interesting parallels could be drawn to show the intimate connection between the phenomena of fermentation and the phenomena of chemical action; but this must suffice to authorize the statement that the complex phenomena of fermentation can be best understood when viewed from the pinnacle of modern chemical theory—the Avogadro-van't Hoff rule, the phase rule, electrolytic dissociation and the doctrine of energy.

Having shown that chemistry helps us to understand fermentation, let us see what light it is capable of shedding upon infection.

INFECTION.

The fact that the poisonous action of the bacteria is due to the soluble products formed by the bacteria was established by Panum in 1874. Later, Koch, Chauveau and others succeeded in separating these poisons from the bacteria, and by inoculating animals with them proved that the proliferation of a number of pathogenic organisms in the body was less injurious to the body than the soluble poisons produced by them. Brieger viewed these poisons as organic bases, the so-called ptomaïns; but, subsequently some of them were shown to be either proteid or proteid-like bodies, and many of them acted not unlike digestive ferments. Brieger and Fränkel named the proteid-like bodies toxalbumins. Among the toxins are uncrystallizable poisons, the complex chemical structure of which has not yet been made out. The ptomaïns are crystallizable products of bacterial activity somewhat analogous to the vegetable alkaloids. Some possess toxic properties, while others do not. The chemical structure of some of them is well known, but the structure of toxalbumins is a problem for future work.

In his work on 'Ptomaines and Leucomaines,' Vaughan points out a very interesting chemical relationship between some of the non-poisonous and poisonous members of the cholin group. Starting with trimethyl-ethyl-ammonium hydroxide, by oxidation cholin, neurin, betaïn and muscarin are derived as follows:

$$\begin{array}{lcl} CH_3 & & CH_2.OH \\ | & & | \\ CH_2 & + O \rightarrow & CH_2 \\ | & & | \\ N(CH_3)_3OH & & N(CH_3)_3OH\,; \end{array}$$

(Trimethyl-ethyl-ammonium hydroxide.) (Cholin.) (Oxyethyl-trimethyl-ammonium hydroxide.)

$$\begin{array}{lcl} CH_2.OH & & CH_2 \\ | & & \| \\ CH_2 & - H_2O \rightarrow & CH \\ | & & | \\ N(CH_3)_3OH & & N(CH_3)_3OH\,; \end{array}$$

(Cholin.) (Neurin: Vinyl-trimethyl-ammonium hydroxide.)

$$\begin{array}{l} CH_2.OH \\ \vert \\ CH_2 \\ \vert \\ N(CH_3)_3OH \end{array} + O_2 \rightarrow \begin{array}{l} CO.OH \\ \vert \\ CH_2 \\ \vert \\ N(CH_3)_3OH; \end{array}$$

(Cholin) (Trimethylglycocoll)

$$\begin{array}{l} CH_2.OH \\ \vert \\ CH_2 \\ \vert \\ N(CH_3)_3OH \end{array} + O \rightarrow \begin{array}{l} CH_2.OH \\ \vert \\ CH.OH \\ \vert \\ N(CH_3)_3OH. \end{array}$$

(Muscarin: Dioxyethyltrimethyl-ammonium-hydroxide.)

The structural formulæ show the little change that is necessary to convert an innocuous substance into a very poisonous one, and *vice versa.* Cholin is only poisonous in large doses while very small doses of neurin and muscarin are highly poisonous. Betaïn is not poisonous.

Methylguanidin $\left(NH : C< {.NH_2 \atop .NH}(CH_3)\right)$, trimethylenediamine $\left(CH_2 : < {CH_2.NH_2 \atop CH_2.NH_2}\right)$, and tyrotoxicon (diazobenzene-potassoxide, $C_6H_5.N_2.OK$) are three other poisonous ptomaïns whose chemical structure is well known. Typhotoxin ($C_7H_{17}NO_2$) is said to be the toxin which gives rise to the typhoid intoxication, and Brieger has been able to separate from tetanus cultures four bases: tetanin ($C_{13}H_{30}N_2O_4$), tetanotoxin ($C_5H_{11}N$), spasmotoxin and one other unnamed toxin. According to Brieger, each of these is capable of inducing tetanic intoxication. Against this last statement is opposed the further statement that tetanus toxin is a toxalbumin.

Roux, Yersin and others succeeded in isolating, seemingly in a state of purity, from the cultures of the Klebs-Loeffler bacillus a toxalbumin, soluble in water, which when inoculated into a guinea-pig produced the phenomena characteristic of diphtheria. Prosecuting this line of investigation, these and other investigators have isolated characteristic toxalbumins from cultures of other germs. These toxalbumins have been divided into two principal groups by Brieger and Fränkel, the classification being based upon their solubility. As previously stated, they are proteid-like bodies, highly complex and poisonous. Their further properties may be considered later; but in passing, an idea of their virulence should be given.

"A tetanus toxin has been prepared, of which 0.00005 milligram killed a mouse weighing 15 grams; a man weighing 70 kilograms, with the same susceptibility, would be killed by 0.23 milligrams. This would make the poison 300 times more potent than strychnine."

Closely related to the toxins which arise as products of bacterial activity there is another group of toxic substances which arise in the living animal tissues as the products of either hyper or of retrograde metabolism of the protoplasm, or result from fermentative action. Some of these are proteid-like bodies (toxalbumins), while others are organic bases (leucomaïns) not unlike the vegetable alkaloids.

The chemical structure of many of the leucomaïns is well known; but the same cannot be said of the toxalbumins. The development of their structure must await the unraveling of the proteids—their chemistry seems to flow in channels parallel with the chemistry of the albumins, globulins, albuminates, proteoses and peptones. At least the poisonous principle clings to these products.

The venom of the snake belongs to this class. According to the researches of S. Weir Mitchell, E. T. Reichert, T. R. Fraser and others, snake venom is a very complex mixture containing in addition to the poisonous substances several bodies that are non-poisonous. The poisonous substances are not ferments. Fraser says: "They are substances that produce effects having a direct relationship to the quantity intro-

duced into the body. This quantity in the case of each serpent varies with its size and bodily and mental condition; with the nature of the bite—whether both fangs or only one has been introduced, whether they have penetrated deeply or only scratched the surface; and with other circumstances related to the serpent, such as whether it had recently bitten an animal or not, and thus parted with a portion or retained the whole of the venom stored in the poison glands. The quantity required to produce death being very exactly related to each pound or kilogram of weight." Fraser found the minimum lethal dose per kilogram to be: "For the guinea-pig (of dried venom), 0.00018 gm.; for the frog, 0.0002 gm.; for the rabbit, 0.000245 gm.; for the white rat, 0.00025 gm.; for the cat, somewhat less than 0.005 gm.; and for the grass snake (*Tropedonotus natrix*), the relatively large dose of 0.03 gm."

It is significant that the toxicity of cobra venom is not the same for all animals. Furthermore, it is exceedingly interesting to find that the experiments carried out by Fraser, *in vitro* and in the animal organism, leave practically no room for doubt that the poisonous action of snake venom and the antagonistic action of antivenin are both chemical. In the unprotected animal snake venom injected beneath the skin or into the blood stream gives immediate evidence of reactions of an endothermic character; but when in the same manner it is introduced into protected animals evidence of exothermic reactions is elicited. When introduced into the stomach of an animal snake venom not only fails to induce symptoms of poisoning, but exhibits a neutralizing action upon inoculated venom, and in the uninoculated animal confers immunity against snake venom. Moreover, the ratio between venom and antivenin is quantitatively brought out in the experiments of Fraser. All this can be shown to be in conformity with well-known chemical laws.

Numerous examples which illustrate the chemical nature of the action of toxalbumins might be drawn from various intra- and intercellular protoplasmic bodies found in the vegetable and animal kingdom, but time will not permit their multiplication here. A bountiful supply is to be found in recent biochemical and medical literature, and interested persons are referred to that source.

The specific phenomena of these poisons as exhibited in the human body when toxic quantities are taken will be found in nearly every text-book of modern medicine, so there is no need to repeat them here.

What has been said of the chemistry of fermentation is equally applicable here. Specific illustrations and their enlargement just now would take us beyond the limits of this address; for that reason it is well to pass on to the consideration of the next phase of the subject.

IMMUNITY.

The problem of immunity is so closely entwined with that of protective inoculation that it will be easier to discuss the two conjointly.

In its broadest sense, immunity represents that state of the living organism (animal or vegetable) which enables it to resist the toxic action of substances, whether such substances be introduced from an external source or are developed within the organism. Specific immunity is a state of immunity against a specific substance. This may be *natural*, as when the organism is normally *non-susceptible;* or it may be *artificial* (acquired), as in the case of protection against disease developed by a previous attack of the disease (as in smallpox), or by some other artificial means (vaccination, for instance).

Vexed as the problem is, much enlightenment is to be gained from an investiga-

tion of artificial immunity. Recalling the researches of Jenner, and the quotation from Ehrlich relative to the work of Pasteur, at that time it appeared as though artificial immunity was brought about by specific micro-organisms. Opposed to this view the investigations of Toussaint, Chauveau, Salmon and Smith, Roux, C. Fränkel and others brought forward evidence to show that artificial immunity could be induced by the 'metabolic products' freed from bacteria—accustoming the organism to the specific poison seemed all-sufficient. Later it was shown by Hueppe, Gamaleia and Buchner that the specific toxins found in the culture fluid outside the bacterial cells were not identical with the protective substances found in the germs and their metabolic products.

At this point Hueppe says: It has been "established that: (1) undergoing the disease; (2) inoculation with attenuated germs; (3) inoculation with disease germs which have become wholly impotent; (4) inoculation with saprophytes, and (5) inoculation with the metabolic products of the parasite, can all confer immunity; while, (6) inoculation with the specific poisons effects no immunization." Then followed the experimental proof that completely attenuated bacteria can no longer produce the specific poison. This effectually separates the protective substance and the poison.

The next important advance was the discovery of substances in the blood serum of animals immunized against diphtheria and tetanus that were able to specifically protect other animals against the toxines of these diseases. This discovery was made by Behring, and it at once opened an entirely new and promising field for investigation.

December 3, 1890, in No. 49 of the *Deutsche med. Wochenschrift*, Behring and Kitasato published an article: 'Ueber das Zustandekomen der Diphtherie-Immunität und der Tetanus-Immunität bei Thieren' in which the statement is made that: "The blood of tetanus-immunized rabbits possesses the property of destroying tetanus toxin. This is possessed by the extravascular blood and is the cell-free serum." They showed that the blood serum of non-immunized animals did not possess this antagonizing action, and that the prepared serum was of therapeutic value. Ogata and Jasuhara proved that blood serum from an animal naturally immune contained substances which, when injected into mice, conferred upon them the same type of immunity. Tizzoni and Cattani (1891) found that the quantitative protective value of the blood serum of animals naturally immune to tetanus (the dog, for instance) could be greatly increased by repeated injections of gradually increasing amounts of tetanus-toxin; and that such serum possessed decided therapeutic value when inoculated into animals suffering from tetanus. This line of investigation has been greatly extended and enriched by Behring, Roux, Koch, Yersin, Haffkine, Pfeiffer, Buchner, Sanarelli, Ehrlich and others, and, as a result, there is to be found in the open market to-day a variety of antitoxin sera, such as antidiptheritic, antitetanic, Marmoreck's antimycotic, antipneumococcic, antibubonic, antirhabic, yellow-fever, etc.

March 20, 1896, Professor Thomas R. Fraser, M.D., at the Royal Institution of Great Britain, presented a very important contribution on 'Immunisation against Serpents' Venom, and the Treatment of Snakebite with Antivenene,' in which, for the first time, the quantitative relation between the 'toxic' and the 'anti' substances is shown. The contribution is rich in splendidly marshaled experimental evidence which leads the author to the logical conclusion that, so far as snake venom is concerned, the antidotism of the 'antivenene' is not the result of physiological reaction, is not due to phagocytic action, nor to the

'resistance of tissues,' but, as I have already pointed out, a chemical theory, implying a reaction between antivenene and venom, which results in a neutralization of the toxic activities of the venom, is entirely compatible with the observed facts.

Another significant fact of chemical importance observed by Fraser is that, in carrying out the immunizing process, "the saturation point of the blood for antivenene is reached before the possible maximum non-fatal dose of venom has been administered." The protective value of venom and 'antivenene' when administered by the stomach has already been mentioned.

By this time the use of diphtheria antitoxin as a therapeutic agent in the treatment of diphtheria had become firmly established. The variation in the results obtained caused Ehrlich to search for a quantitative relation between the toxin of diphtheria and the antitoxin of diphtheritic serum. The result of Ehrlich's investigation is to be found in the Croonian lecture delivered by him before the Royal Society, London, March 22, 1900. 'By means of test-tube experiments with suspended animal tissues' he brought out some very interesting facts. "The relations were simplest in the case of red-blood corpuscles. On them, outside the body, the action of many blood poisons, and of their antitoxins, can be most accurately studied, *e. g.*, the actions of ricin, eel-serum, snake poison, tetanus toxine, etc. * * * By means of these test-tube experiments, particularly in the case of ricin, I was able, in the first place, to determine that they yielded an exact quantitative representation of the course of the processes in the living body. * * * It was shown that the action of toxine and antitoxine took place quantitatively as in the animal body. * * * It was proved in the case of certain toxines—notably tetanus toxine—that the action of antitoxines is accentuated or diminished under the influence of the same factors which bring about similar modifications in chemical processes —warmth accelerates, cold retards the reaction, and this proceeds more rapidly in concentrated than in dilute solutions. * * * The knowledge thus gained led easily to the inference that to render toxine innocuous by means of antitoxine was a purely chemical process, in which biological processes had no share."

The distribution of the toxins and the antitoxins in the system is a matter of prime importance, yet not more than a beginning has been made looking toward their localization. That they do possess a selective action has been established by Stokvis, Dönitz, Pfeiffer, Marx, Wassermann and Roux, and these facts throw a great deal of light upon the phenomena of incubation, time reactions, antitoxic action, protective action, serum therapy, etc.

The phenomena of agglutination and lysogenic action, the recent work of Buchner in Germany and Bordet in France, on hæmolysis, and some experimental work on ionic reactions done in my own laboratory, deserve consideration here; but time presses for a summation, and they must be passed without further comment to a future occasion.

From accumulated facts, *acquired immunity* is separable into two distinct types. (The following classification is borrowed from Muir and Ritchie.)

A. Active immunity, *i. e.*, produced in an animal by an injection, or by a series of injections, of non-lethal doses of an organism or its toxines.
 1. *By injection of the living organisms.*
  (*a*) Attenuated in various ways. Examples:
   (1) By growing in the presence of oxygen, or in a current of air.
   (2) By passing through the tissues of one species of animal (becomes attenuated for another species).
   (3) By growing at abnormal temperatures, etc.
   (4) By growing in the presence of weak antiseptics, or by injecting the latter along with the organism, etc.

(*b*) In a virulent condition, in non-lethal doses.

2. *By injection of the dead organisms.*

3. *By injection of filtered bacterial cultures, i. e., toxines; or of chemical substances derived from these.*

These methods may also be combined in various ways.

B. Passive immunity, *i. e.*, produced in one animal by injection of the serum of another animal highly immunized by the methods of A.

1. *By antitoxic serum, i. e.*, the serum of an animal highly immunized against a particular toxine.

2. *By antimicrobic serum, i. e.*, the serum of an animal highly immunized against a particular organism in the living and virulent condition.

The protective value of active immunity extends through a considerable period of time, while that of passive immunity is evanescent.

An adequate explanation of this vast array of facts is yet before us. The explanation in detail cannot be given to-night; that must await another time; but some generalizations must be made.

1. *Pasteur's theory of exhaustion* of the pabulum is disproved by the fact of passive immunity.

2. The *theory of retention* will have to be greatly modified before it can explain many facts with which it is now in opposition.

3. The *theory of acclimatization or habituation* has limited application and, like the theory of adaptation, takes too little cognizance of details.

4. *Metchnikoff's theory of phagocytosis* falls before the facts of passive immunity; and

5. The *humeral theory* only presents another phase of its own evolution.

6. *Buchner's hypothesis*, which explains immunity as being due to the reactive changes in the integral cells of the body resulting from the action of chemical products absorbed from the seat of vaccination or inoculation, is strongly supported by experimental evidence; and

7. *Ehrlich's side-chain* (*Seitenkette*) *theory* presents an exceedingly ingenious and interesting explanation of the phenomena of immunity adduced by experiments *in vitro* and *in vivo*.

By elimination the problem may be somewhat simplified. The facts themselves may be roughly divided into two groups: (1) biological, and (2) chemical; and the explanations will then be either biological or chemical. In the ultimate analysis, the biological explanation will rapidly pass from the body as a whole to its respective organs and their respective cells, to the nucleated cells, and finally to the biogen of the nucleus; while the chemical explanation will describe the cycle that begins with the minutest atomic reaction, passes onward through more and more complex intra- and intermolecular synthetic and analytic changes so long as chemical equilibrium is disturbed; but eventually finds its beginning and its end—cause and effect—in energy potential, energy kinetic, liberating impulse.

That the problem of immunity will be solved is only a question of time. The active research now in progress is rapidly dissipating the unknown; and when the chemical structure of the various animal proteids becomes a known quantity their interaction will be readily seen and the solution of the problem will be an accomplished fact.

The problem is a biochemical one, and biochemists will solve it. Many, if not all, the phenomena of fermentation, infection and immunity are explainable in terms of modern chemistry, and since modern chemistry is firmly founded on the doctrine of energy we have to consider merely the terms, *energy potential*, *energy kinetic* and *liberating impulse*.

I am conscious of having failed to bring before you a large mass of newly accumulated, interesting facts which should be considered in this connection; but the largeness of the subject together with the enormous accretions annually made to its

literature renders it impossible to present a complete survey of so immense a field of labor in the address of an evening. What has been said is little more than a beginning of what has been done in this line of biochemical research—the promise of its future remains to be told.

Beside the great intellectual gain must be placed the immense practical benefits such investigations have secured for man—as witnessed in the saving of millions of lives of human beings, many times more of the lower animals, and large areas of plant life. They have ever made for the betterment and happiness of man, and for the highest progress of civilization, and so will they continue.

HENRY WINSTON HARPER.

AN ELECTROCHEMICAL LABORATORY AT THE UNIVERSITY OF PENNSYLVANIA.

THE great importance of electricity in chemistry is universally recognized. Universities and technical schools are rapidly adding appliances for the use of this agent to their chemical equipments. Here, at the University of Pennsylvania, the first work done in electrochemistry was in the year 1878. It consisted in the precipitation of cadmium from its salts, also the separation of this metal from copper, and the precipitation of uranium as protosesquioxide by the electric current. Since that time numerous other methods have been devised, and the practical work has been greatly amplified and incorporated in the course of chemical instruction designed for undergraduate and graduate students in chemistry.

The electric energy was, at first, derived from various types of primary batteries, but as the demand for powerful and steady currents grew, several storage cells of the Julien type were introduced, early in the year 1888, and constantly used until 1895, when the equipment was increased by the addition of twelve chloride accumulators (Type E), connected to a plug-board, by which any number of cells could be arranged in series or parallel, and attached to any one of three sets of terminals, conveniently placed on a working table. Fig. 1 represents a photograph of the table, showing the board in position. The storage cells were placed in the cupboard back of the distributing board. The arrangement of the plug-board with its connections is clearly indicated in Fig. 2, where the lettered and numbered squares represent brass blocks mounted on a slab of hard rubber, and the dotted lines indicate the electrical connections on the back. Provision was thus made for three students.

As this device and our present laboratory were installed at the writer's suggestion and under his direction by A. W. Schramm, of the Electrical Department of the University, it seems best, to insure accuracy and avoid uncertainty, to introduce the latter's own language in describing the two schemes:

"The brass blocks marked P are each connected to the positive terminal of a storage cell. These cells are marked in the figure by A, B, C, etc. The negative terminals are each connected to two blocks marked N, as shown. The upper line of blocks, numbered 1, are joined together, and, in fact, might be made of one strip except for economy of material. This row is attached to, and forms part of, the positive lead running to outlet No. 1 on the operating table. The negative lead for this same outlet is connected to the lower row of blocks marked 1. Thus: If the operator at outlet No. 1 wanted to use the two cells A and K in parallel it would only be necessary for him to insert plugs between the upper row of 1 blocks and the P blocks of A and K respectively, and between the N blocks of A and K, and lower row of 1's. Similarly, the upper row of blocks marked 2 are connected to the positive lead running to outlet No. 2, and the

lower row of blocks marked 2 are connected to the negative lead of the same outlet. And so on with the blocks marked 3. It will be noticed that one of the two above-mentioned N blocks is located in the same row with the P blocks, and this N block of one cell is adjacent to a P block of its neighbor. This is for the purpose of connecting cells in series.

"For instance, suppose that the operator at outlet No. 2 wanted to use cells B, C and D in series, he would connect the P block of cell B to 2, the P block of C to the N of B, and the P block of D to the N block of C, finally connecting the N block of D to its adjacent 2 block.

"In addition to the above, the operator at 3 could insert plugs so as to use the cells E, F, G, H, I, J in a combination of all in parallel, three in parallel two in series, two in parallel three in series, or all in series, just as occasion might demand.

"The cells were charged (generally at night) by connecting circuit No. 1 to the 110-volt lighting circuit by means of a small knife switch, conveniently located at the side of the operating table. Incandescent lamps placed in this charging circuit kept the current down to the desired value. The cells were then all connected in series and across the No. 1 leads. Making No. 1 leads the charging circuit also provided means for using the 110-volt current for electrolytic work where the solutions were of such high resistance that the twelve cells in series were insufficient to produce the desired results. Portable resistance frames were provided, consisting of wooden frames mounted on neat iron feet, having German-silver wire coils stretched between brass blocks on both sides. There were sixteen pairs of coils of one resistance, and ten pairs of one-tenth of that resistance, all joined in series between two binding posts, and so arranged that any number of coils of either denomination could be short-circuited by means of two plugs; thus the resistance could be altered by small steps.

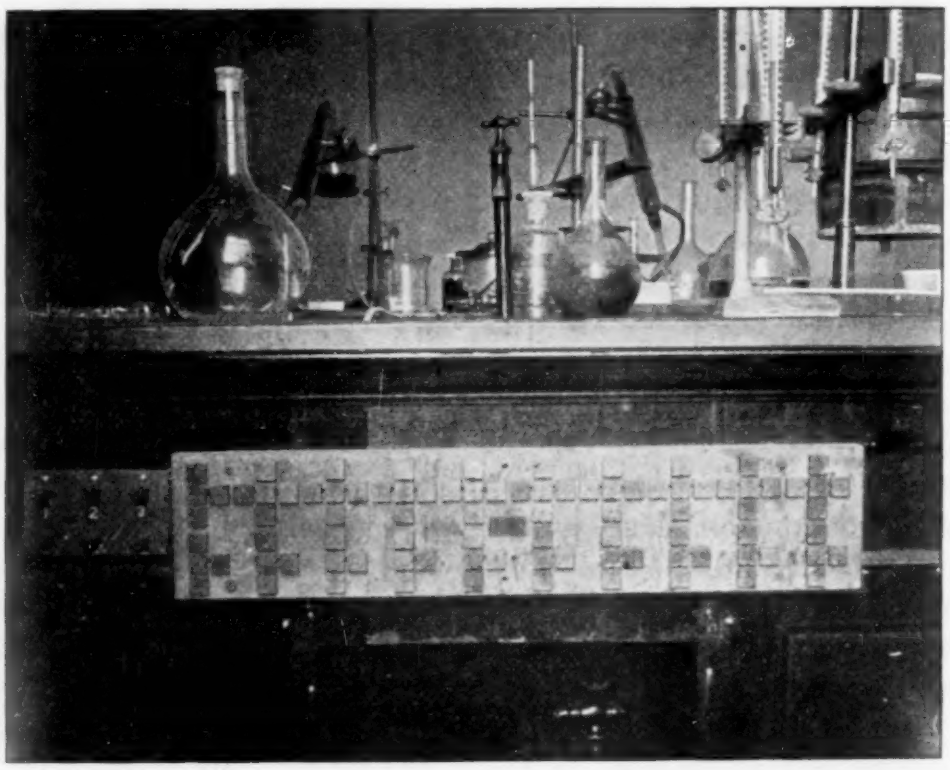


FIG. 1. Old Working Table.

A third plug was provided to prevent the necessity for opening the circuit when altering the resistance. The measuring in-

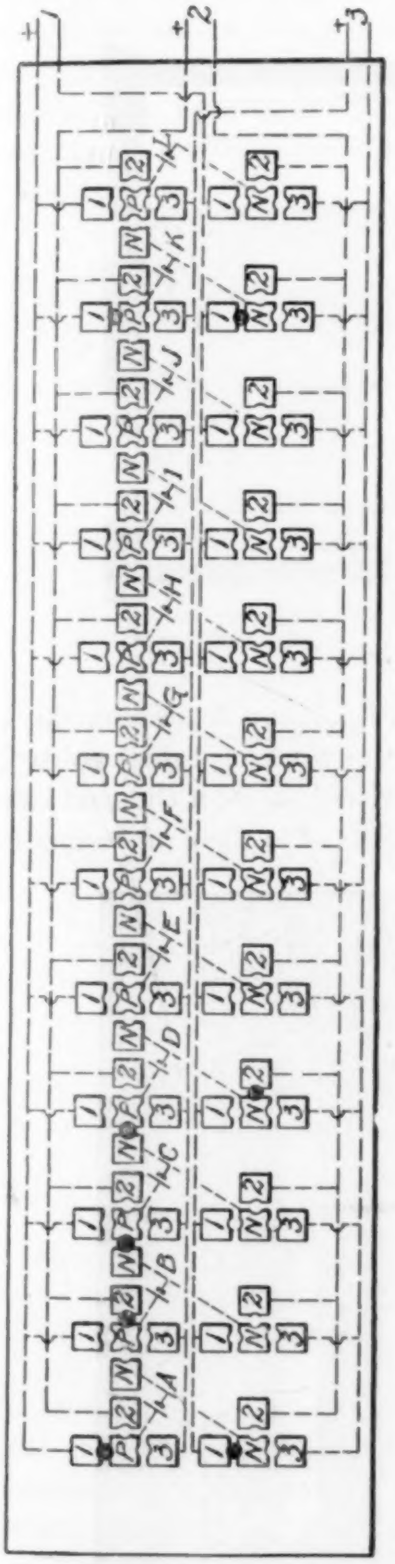


FIG. 2. Old Distributing Board.

struments were portable, Weston's and Hartman-Braun. This entire electrical equipment was fairly satisfactory and was duplicated later. It had many defects; for instance, it was possible to connect cells in parallel and series at the same time and the student sometimes preferred to make connections haphazard rather than work out and understand the whole scheme. And even though he did understand it, the chances for making a wrong connection were too great because of the confusingly large number of blocks on the boards. The resistance frames had the fault that the German-silver wire soon became so corroded as to break. Replacing the coils by tinned steel wire proved to be little or no improvement. The portable instruments, too, were in danger of being injured by solutions being spilled on them, and sometimes received rather rough handling, which soon decreased their usefulness.

"For these reasons, and the growing demand for training in electrochemistry, it was finally decided to provide a laboratory and installation sufficient to accommodate eighteen students. The effort was also made to overcome as fully as possible the defects of the previous arrangement. It will readily be seen that the matter of complication would be made indefinitely worse if the number of outlets were increased to eighteen and the number of cells to fifty, so an entirely different arrangement of switchboard had to be devised. The only room available was one fifteen feet by twenty-six feet, as shown in Fig. 3, and it soon became evident that this room would not accommodate more than sixteen students, allowing each individual three feet by twenty inches of table space.

"Storage cells were, because of their constancy, decided upon for this installation. Those in use have 120 ampère hours' capacity, with a normal discharge rate of 15 ampères and a maximum rate of 30 ampères. Two groups of twenty-four cells each were located in the compartments shown; they supply their respective sides of the room.

They are supported on racks of four shelves each, six cells per shelf. Each shelf is thoroughly paraffined and a half inch layer of ground quartz placed around the jars. two of them each controlling the six places on their respective sides of the room, and the third controlling the four places in the center. The face of one of these boards is

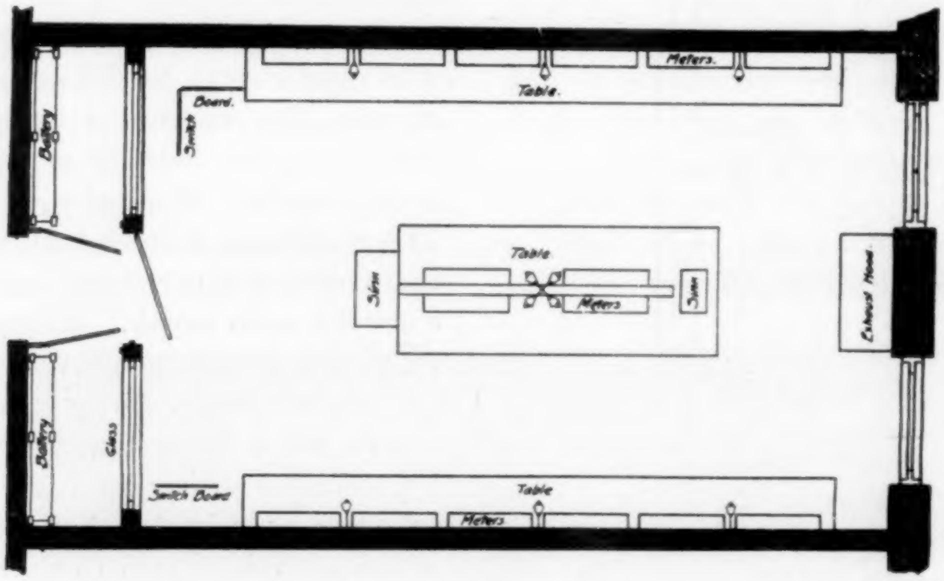


FIG. 3. Electrolytic Laboratory.

Fig. 4 shows one of these compartments with the lead wires and cut-outs for each cell.

"The switchboards are three in number, shown in Fig. 5, the letters on the face referring to the working tables controlled.

"The switchboard on the east side of the room consists of a slab of enamelled slate

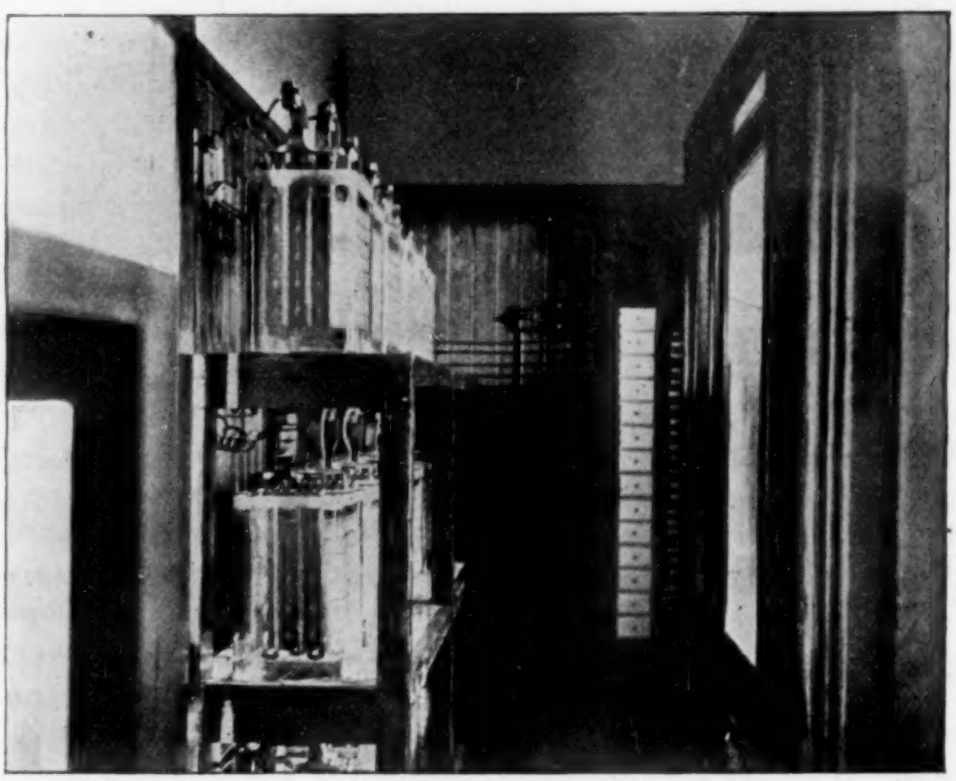


FIG. 4. Battery Room.

24 by 34 inches, one inch thick, and contains, for each of the six outlets to be controlled, one circle of twenty-five contact pieces, and has two spring levers, insulated from each other and moving about a common center, sweeping over them. The contact blocks are numbered consecutively from 0 to 24 and a stop is provided to prevent the levers from sweeping past the zero. Cell No. 1 is connected between blocks numbered 0 and 1 in each of the six circles, cell No. 2 between blocks numbered 1 and 2, and so on for the remainder of the twenty-four cells in that group, so that all blocks similarly numbered on the one board are connected together, and but a single wire leads from the six similarly numbered blocks to the junction between two cells. In this lead is provided the usual fuse. The circles are lettered A, B, C, etc., consecutively, corresponding with the letters at the outlets to be controlled.

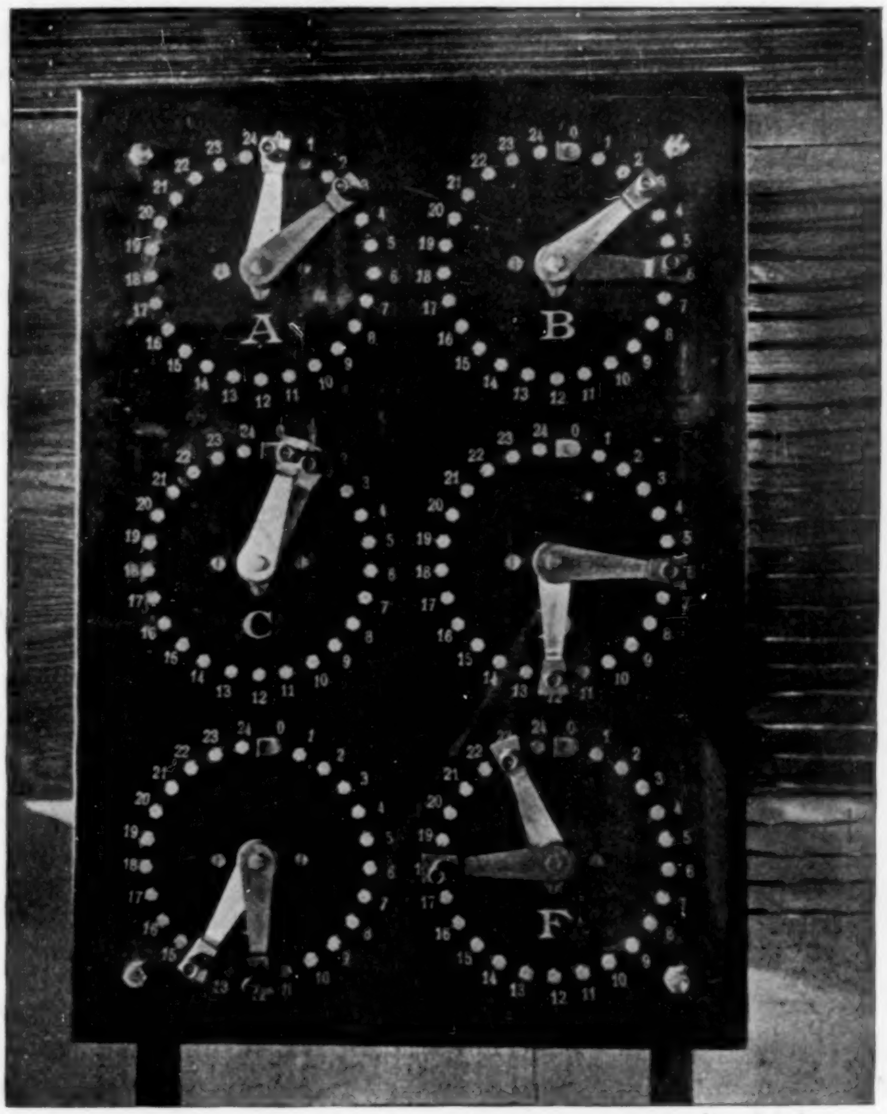


FIG. 5. Distributing Board.

"Should the operator at the outlet E, for instance, need two cells, he goes to this board, and finding that the cells from the twelfth cell forward are not being used in any of the circles, he places one of his levers on contact block No. 12 and the other one on No. 14. There is thus very little chance of doing anything wrong, or for persons to interfere with one another, because there is no necessity to use the same cells, and at a

glance one can observe which cells are in use. Fig. 6 shows the electrical connections from one of these distributing boards to the cells and outlets on the working tables. The levers themselves are too narrow at their outer ends to reach across from one block to another, to prevent short circuiting the cells, so they are provided with fiber extentensions on each side to prevent their falling between the blocks, and also to prevent their making contact with each other. The switchboard on the west wall is exactly similar to the one just described, it containing the circles G, H, I, K, L, and M, while the third one, which controls the four outlets on the center table, is but twenty-four inches square, but has twenty-six contact blocks in each circle. They are numbered 0, 24, 25, 26, and so on to 48. Between the two blocks numbered 0 and 24 are connected the cells of the group on the east side of the room; between the blocks 24 and 25 is connected cell No. 1 of the west side of the room, while cell No. 2 is connected between blocks numbered 25 and 26. This arrangement connects the two groups of cells in series, and permits the use of from one to forty-eight cells at the center table when necessity requires. It will, perhaps, have been noticed that there is no provision made for connecting cells in parallel, and this is not necessary, as the maximum discharge rate of the cells exceeds the greatest estimated current needed by one operator. All brass parts on the back of the board, as well as the bared ends of the wires, are thoroughly coated with P. and B. paint, while the brass parts on the front are heavily lacquered to prevent corrosion. The surface of the contact blocks can easily be cleaned with fine sandpaper.

"The measuring instruments, after some deliberation, were chosen of the switchboard type. While this necessitated procuring at least one-third more instruments, yet the initial cost was considerably lower than if portable instruments had been provided, and experience with portable instruments leads me to believe that a greater accuracy will be attained with switchboard instruments of a good form, if not immediately, yet surely after the first six months of use.

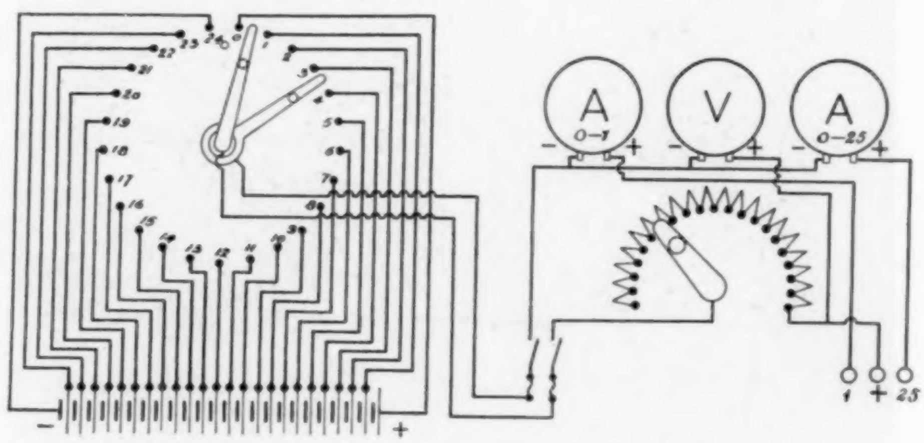


FIG. 6. Connections to Working Table.

"Each outlet is provided with a fused switch, a voltmeter, two ammeters, a rheostat and a terminal board. They are connected as shown in Fig. 6. The positive lead after passing through the variable resistance runs directly to the positive binding post. The wire coming from the negative binding post runs to the low reading ammeter and thence to the negative side of the switch, while the negative post marked 25 is connected to the same switch terminal,

but through the ammeter of large capacity. The anode of the electrolytic cell is therefore always connected to the middle binding post and the kathode either to the post 1 or 25, depending upon the strength of current it is intended to pass through the cell. The voltmeter, being connected as shown, measures the potential differences at the terminals of the cell, except for the addition of the small fall of potential through the ammeters.

"The voltmeters on the side of the room have scales ranging from 0 to 50, and divided to 1–2 volts. Those on the center table range from 0 to 120.

"The ammeters ranging from 0 to 1 ampère are divided to 1–100 and those reading from 0 to 25 are divided to 1–5 ampères. The three instruments are mounted side by side on an oak backboard extending the whole length of the room and are covered by an air-tight case with a glass front, as shown in Fig. 7. The cases have neither doors nor a back, but are simply screwed against a backboard with a heavy felt gasket, making the joint. The wires come out through hard rubber tubes sealed at their outer ends by insulating tape. The rheostats are of the enameled type, chosen because of their being impervious to fumes. They have a total resistance of 172 ohms, divided into 51 steps in such a way that their resistances form a geometrical progression. The first step, and the sum of all the steps, being chosen in accordance with data of the resistances of the baths determined for the work done under the old system.

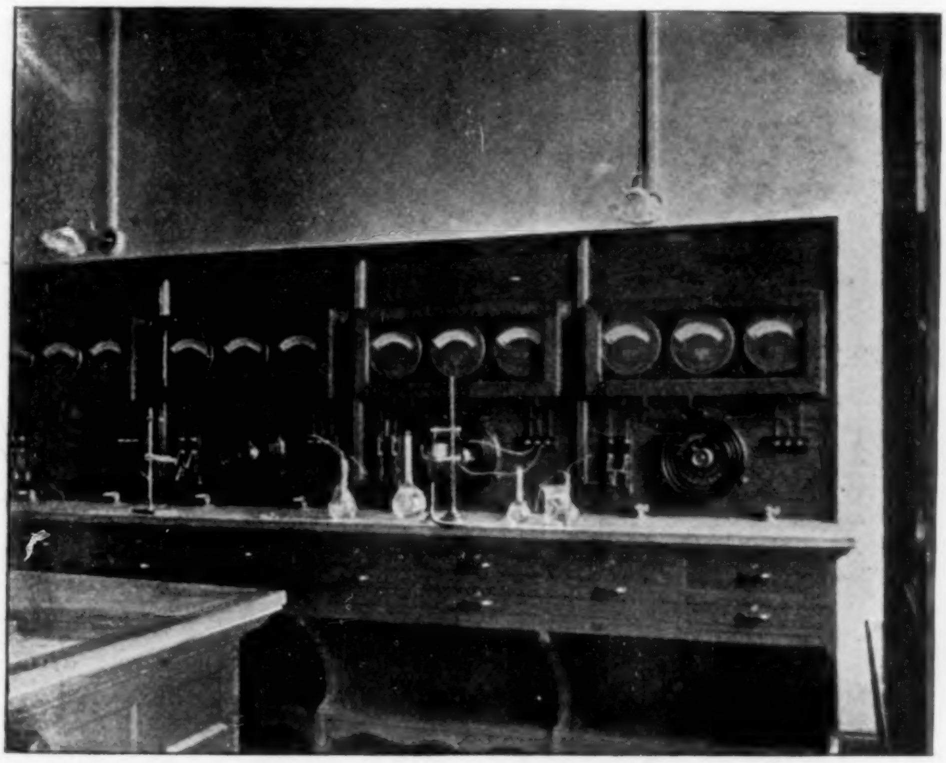


FIG. 7. Working Table.

"The wires, both those in the battery rooms and those in the laboratory proper, are covered with rubber, and those in the laboratory are further encased in oak molding, but this rather for appearance's sake than for protection. The whole installation, as well as the other fittings of the room have a very neat and finished appearance.

The problems investigated by students in

this laboratory are the study of the influence of current density and concentration upon the course of chemical reactions, the application of gas analysis to the study of the latter (in the formation of hypochlorites and chlorates), ion transference (in the electrolysis of dilute sulphuric acid or sodium hydrate) with a diaphragm, formation of persulphuric acid (influence of concentration, of current density, of temperature), metal precipitations with soluble and insoluble anodes, the introduction of aid-reactions, experiments with molten electrolytes, experiments with multipolar electrodes, the determination and separation of metals, the electrolysis of a series of organic compounds (reduction and synthesis), etc.

The writer is indebted and under many obligations for this installation to Provost Harrison who provided the necessary funds.

In conclusion it may be said that in a second room close by there is also provision for work at high temperatures. A Moissan and two Borscher's furnaces are used for this purpose. They are in direct connection with a 50-horse-power dynamo and are furnished with satisfactory resistance and measuring instruments. They are applied in the reduction of oxides, in the electrolysis of fixed salts, the production of alloys, etc.

The two laboratories afford all that is essential to acquaint the student with the fundamentals of electrochemistry, and give him also ample facilities for research in this domain of chemical science.

EDGAR F. SMITH.

LEGISLATIVE RECOGNITION OF SCIENTIFIC WORK.

It is not often that SCIENCE has the opportunity of chronicling an event such as happened at Madison, Wis., on March 27th, when the Legislature of the State in open session presented to Dr. S. M. Babcock, of the University of Wisconsin, a beautiful

bronze medal 'recognizing the great value to the people of this State and the whole world' of his inventions and discoveries, 'and his unselfish dedication of these inventions to the public service.'

Governments such as ours are not prone to recognize deeds of scientific men, but the service rendered in this connection was of such value that the State has honored itself by paying honor to the man who refused to take out a patent on his invention, but gave it freely and willingly to the people.

Dr. Babcock's discoveries in the field of agricultural science have been many,

but the development of his system of rapidly determining the amount of butter fat in milk has practically revolutionized the dairy industry. It saved the system of factory dairying from destruction by giving a method for the equitable division of moneys earned, and its rapid extension into all dairy countries of the world has contributed much to the renown of American science in other parts of the earth.

The recognition of Dr. Babcock's services by the State of Wisconsin is not confined to such narrow geographical limits. Although not an exhibitor, last year he was awarded the Grand Prix d'Honneur at the Paris Exposition. Recently the dairymen of New Zealand have sent him a beautiful testimonial in the shape of an elegantly bound hand-painted album of New Zealand scenery.

Dr. Babcock's fame as an inventor rests largely upon his milk test, but to men of science, who are familiar with dairy and agricultural investigations, his many discoveries in these fields are regarded as even more brilliant and of more value to science than the invention for which he is now honored.

SPRING MEETING OF THE COUNCIL OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE spring meeting of the Council was held in the Assembly Hall of the Cosmos Club on the afternoon of April 17, 1901. There was a larger attendance of members than is usual at the spring meeting.

The permanent secretary presented a report upon the operations of his office since the midwinter meeting of the Council, including with this a report of the committee appointed at the midwinter meeting and empowered to act upon the applications for membership received in the interim between the midwinter and spring meetings. The report of the committee was very encouraging. It seems that by means of letters signed by the president and the permanent secretary, and addressed to teachers of science in the universities and collegiate institutions of the country, a large number of new members has been added to the rolls of the Association. Further, local committees have been formed at several hundred points in the United States, and empowered by the president and permanent secretary to make an effort to increase the number of members in their several localities. As a result of this work 540 new members have been elected since last Christmas, a number of these being very prominent men of science, who, although formerly members of the Association, had for one reason or another allowed the membership to lapse.

The general condition of the Association was reported to be admirable. In point of number of members the high-water mark was reached in 1891 at the Washington meeting, when there were 2,054 members on the rolls of the Association. At the present time the actual membership of the Association paid up to January 1, 1901, is in the neighborhood of 2,350 while about 100 additional members have been recently elected, but have not yet completed membership.

The permanent secretary further reported that the arrangement with the journal SCIENCE is apparently giving perfect satisfaction and is greatly helping the Association in many ways.

The arrangements for the Denver meeting were reported to be progressing favorably. Local committees in Denver are organizing and a railroad rate of one fare plus two dollars west of Chicago has already been gained. No definite conclusions have been reached by the passenger associations east of Chicago, but it is expected that the details will be settled and that the preliminary announcement concerning the meeting will

be issued to all members of the Association by the middle of May.

The permanent secretary presented his financial statement for the year ending December 31, 1900, which showed receipts amounting to $12,321.60, and expenditures, including $1,300 transferred to the treasurer, amounting to $7,579.84, leaving a balance to new account of $4,741.76. Some unusual expenditures were mentioned in this account, especially the expenses of the New York meeting, which were borne by the Association instead of by the local committee as at previous meetings, and the storage on back volumes and the expense of their removal to New York, where they are now stored free of charge to the Association in the Library of Columbia University. The account, having been properly audited, was accepted by the Council and ordered printed in the next volume of *Proceedings*.

Changes in their personal plans for the summer having necessitated the resignations of Professor Lord, Secretary of Section A; Dr. Reed, Secretary of Section B; Mr. Penrose, Secretary of Section E; and Miss Benneson, Secretary of Section I, their resignations were accepted. Dr. G. A. Miller was elected to fill the vacancy as secretary of Section A, and provision was made for the temporary filling of the other vacancies by committees.

Dr. C. S. Minot presented a report on behalf of the committee appointed to consider the plan of securing a convocation week immediately after the Christmas holidays. The Association of Universities, consisting of the fourteen leading American universities, passed unanimously a resolution recommending that a week be set aside for the meeting of scientific and learned societies, and steps are now being taken to secure from the universities an agreement not to hold their sessions during the week in which the 1st of January occurs.

Dr. Thomas Wilson made a report of progress on behalf of the committee on the protection and preservation of objects of archeological interest, showing that a bill had been carefully drafted and had nearly passed Congress last session, being laid aside only on account of urgent legislation.

The permanent secretary was instructed to take up the matter of the preparation of an index to the first fifty volumes of the *Proceedings* and to take such preliminary steps as he might deem advisable, and report in full at the Denver meeting.

SCIENTIFIC BOOKS.

Gli Insetti Nocivi. By Dr. A. Lunardoni and Dr. G. Leonardi. Naples. 4 vols. 1889–1901.

Since our knowledge of European economic entomology has largely been drawn from books descriptive of the injurious insects of middle Europe, it is a distinct pleasure to have before us for reference a large and valuable work on the injurious insects of a part of southern Europe—the Italian region. This work is, however, more than a compendium of the noxious insects of Italy; it is, practically, a text-book of Italian entomology with detailed accounts of injurious species. Volumes I. and II., dealing with the general subject, Coleoptera and Lepidoptera, are by Dr. Lunardoni; Volumes III. and IV., dealing with the remaining orders, are by Dr. Leonardi. Volume I. contains 570 pages; Volume II., 287 pages; Volume III., 549 pages; and Volume IV., 862 pages.

In the general subject are included directions for the control of noxious insects. Of special interest in the part on Coleoptera is a table for the determination of the species of *Scolytini* according to the nature of their galleries. In the second volume, dealing with the Lepidoptera, the chapters treating of the Tortricidæ and Tineidæ are very full. The discussion of remedies for species in these two families is of considerable value to American workers, since many of these moths are injuriously abundant in the United States.

In the third and fourth volumes the figures are more numerous and the bibliographic lists

more complete, but unfortunately the typographical errors are rather annoying. The Hymenoptera occupy 170 pages of Volume III, the larger part of which treats of the gallflies and sawflies. The Diptera occupy the remainder of Volume III., and are treated at more length than the preceding orders. The fleas occupy the position of a family at the end of the order. Several Trypetidæ, especially *Dacus oleæ*, *Ceratitis hispanica* and *Rhagoletis cerasi* are treated in much detail. The Hessian fly, which appears under the unfamiliar generic name of *Mayetiola*, occupies fourteen pages.

In the fourth volume the Neuroptera are passed over rather hastily. The Pseudoneuroptera are included under the Orthoptera. The Hemiptera receive the fullest treatment of all. Over 180 pages are occupied with the Aphidæ, and 200 with the Coccidæ. *Phylloxera* covers 75 pages. Nearly all the Coccidæ are figured. Under the name of *Aonidiella perniciosus*, a long account is given of the San Jose scale. In the Orthoptera considerable space is devoted to the remedies for grasshoppers; spraying machines and catching machines, drawn by two men, seem to be especially favored. The volume concludes with a brief notice of the Thysanura under the ordinal name of Pseudoinsecta.

NATHAN BANKS.

An Introduction to Modern Scientific Chemistry, in the form of popular Lectures suited for University Extension students and general readers. By Professor LASSAR-COHN, Ph.D., University of Königsberg. Translated from the Second Edition by M. M. PATTISON MUIR, M.A., Cambridge. New York, D. Van Nostrand Company. Pp. viii + 348. Price, $2.00.

The author's preface says: "In this introduction to *Modern Scientific Chemistry* an attempt is made to give a succinct and accurate presentation of chemistry on strictly scientific lines, and at the same time in as popular a form as is compatible with the vast range of the subject. The book can be followed easily by any one who takes a serious interest in natural science, and will not, I hope, be unwelcome to the younger chemists who are still pursuing their studies. A teacher of chemistry who may not have paid special attention to the methods of presenting his subject will perhaps find in the book something useful to himself and helpful to his hearers."

A careful examination of the text impresses one with the idea that the author has made a particularly happy use of the word modern in his title; and that the promises of the preface have been abundantly fulfilled. The author has been eminently successful in solving the difficult problem of giving the theories and facts of chemistry in a form not only popular but exact. The keynote of the book is its emphasis of the fundamental conceptions of the science.

The style is clear, convincing and always interesting. While the book is intended primarily for University Extension students and general readers, to the student and younger teachers of chemistry it offers a wealth of valuable, accurate information, especially concerning the chemical principles involved in the manufactures of illuminating gas, smokeless powders and other explosives, fertilizers, matches, glass, aluminium, etc.

The reader who does not find this book helpful and inspiring must be very well informed in scientific chemical subjects.

The translation is excellent, and will serve to introduce Professor Lassar-Cohn's work to a new world of readers.

The crudeness of the illustrations (by the author) is the only unsatisfactory feature of a book of rare merit.

WILLIAM B. SCHOBER.

LEHIGH UNIVERSITY.

An Elementary Treatise on Qualitative Chemical Analysis. By J. F. SELLERS, Professor of Chemistry, Mercer University, Georgia. Boston, Ginn & Company. 1900. Pp. ix + 160.

The author has attempted in this treatise to place qualitative analysis upon a scientific basis, to do for this subject what Ostwald has done for analytical chemistry in general. It is very evident from the nature and arrangement of that part of the book devoted to the theory of solutions that it is a reflection of Ostwald's 'Foundations of Analytical Chemistry.' As such it is to be commended. The book, how-

ever, is evidently intended for a younger class of students than Ostwald intended his work. The author has so condensed the subject, and has attempted to cover so much ground, that it is believed it will be difficult for the student to grasp the real significance of the subject. It would have been a much more valuable book if the theory of solutions had been presented more simply, perhaps at some greater length, and with more numerous discussion of examples.

Some of the statements will, undoubtedly, give the student a false impression. On pages 19 and 21 it is stated that the amount of dissociation is increased by heat, giving the impression that this is a general law. Again, on page 21 one gets the idea that the greater the dilution the greater is the chemical activity. The explanation of the effect of a salt of a weak acid on the strength of a strong acid is merely a statement of fact.

That portion of the book, pages 27–157, devoted to the processes of qualitative analysis is well arranged, practical and progressive, including all the more recent and approved methods of separation. Considerable stress is laid upon spectroscopic analysis. The application of normal solutions to laboratory reagents is to be commended. H. F.

Laboratory Instructions in General Chemistry. By ERNEST A. CONGDON, Professor of Chemistry, Drexel Institute. Philadelphia, P. Blakiston's Son & Co. 1901. Pp. viii + 110.

It is difficult to review justly a laboratory book of experimental chemistry which is primarily intended for the author's own students, because there is no means of knowing what instruction the student has received from the lectures which accompany the laboratory course. When, however, it is stated that the book can be used with any standard text-book, the reviewer's task becomes much simpler, since the laboratory guide is supposed to follow somewhat closely the text of the standard work.

The first 21 pages of this book are devoted to experiments illustrating principally the laws of physical and chemical changes, and chemical reactions. These experiments, if the student is expected to follow them in order, are poorly selected and badly arranged. Indeed many of them are entirely out of place. Some of the experiments involve the use of substances, the properties of which must be entirely unknown, and it would be impossible to explain at so early a stage the nature of the reactions taking place. The student is asked, on his second or third day in the laboratory, to try the following experiments: the action of sulphuric acid on a mixture of potassium chlorate and sugar, the preparation of gunpowder, and red and green fires. These experiments undoubtedly do represent physical and chemical changes, but perhaps too violently for a beginner. Under the chapter on reactions, the student is asked to write the reactions between ferric chloride and ammonia, and ammonium sulphocyanide, ferric hydroxide and hydrochloric acid. All this before oxygen has been studied!

Beginning with oxygen, however, the experiments are the standard experiments to illustrate the properties of the various elements.

An appendix of fifteen pages contains quantitative experiments to illustrate the laws of definite and multiple proportions and the various gas laws. It is believed that some of them are too difficult for first-year students in chemistry. H. F.

The Chemists' Pocket Manual. A Practical hand-book containing tables, formulas, calculations, physical and analytical methods for the use of chemists, assayers, metallurgists, manufacturers and students. By R. K. MEADE, B. S., Instructor in Chemistry in Lafayette College, Easton, Penn. Easton, Penn., The Chemical Publishing Co. Price, $2.00.

The nature and general contents of this book are described in the title. The book is well printed and contains such information as a chemist is almost daily in need of, and can be highly recommended as a reference book. The only feature of the book about which anything else than praise can be expressed is the price at which it is sold. The book is about 4 x 6 inches and contains 193 pages. The 'Chemiker Kalender,' the general nature of which this book follows, with its supplement, contains about three times the amount of material found in this book and only costs one half as much.

J. E. G.

BOOKS RECEIVED.

Le système métrique des poids et mesures. G. BIGOURDAN. Paris, Gauthier Villars. 1901. Pp. vi + 458. 10 fr.

A Treatise on Electro-magnetic Phenomena and on the Compass and its Deviations. COMMANDER T. A. LYONS. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1901. Pp. xv + 556.

Phycomyceten and Ascomyceten. ALFRED MÖLLER. Jena, Gustav Fischer. 1901. Pp. xii + 318 and 11 plates. Mk. 24.

Elementary Questions in Electricity and Magnetism. MAGNUS MACLEAN and E. W. MARCHANT. London, New York and Bombay, Longmans, Green & Co. 1900. Pp. 59.

The Romance of the Heavens. A. W. BICKERTON. New York, The Macmillan Co.; London, Swan, Sonnenschein & Co., Limited. 1901. Pp. iii + 284. $1.25.

Text-book of Zoology, treated from a Biological Standpoint. OTTO SCHMEIL. Translated from the German by RUDOLF ROSENSLACK. Edited by J. T. CUNNINGHAM. New York, The Macmillan Co.; London, Adams and Charles Black. 1901. Pp. xvi + 493. $4.00.

Diseases in Plants. H. MARSHALL WARD. London and New York, The Macmillan Co. 1901. Pp. xiv + 309. $1.60.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Botanical Gazette* for April contains further descriptions of new species of North American trees by Professor C. S. Sargent. Among them are thirteen species of *Crataegus*, which is proving to be one of the most prolific of our genera in species, a new *Betula* from Alaska, and a new *Cupressus* from California. Professor C. O. Townsend writes upon the effect of hydrocyanic acid gas upon grains and seeds. Since this gas has become extensively used for fumigating purposes, it has become important to determine its effect upon the germination of seeds and upon their use as food. Professor Townsend has demonstrated that if the grain and seeds are dry the influence of the gas upon the vitality is far less marked than if they are moist. Dry seeds treated with the gas are not injured for food, but damp seeds should not be used until several hours after removal from the gas. Mr. A. C. Life contributes an interesting study upon the tuber-like rootlets of *Cycas revoluta*, in which the rôle played by the fungi and by the algae upon the formation of these tubercles is worked out. Mr. Newton B. Pierce describes a new bacteriosis of the walnut which has become a well-marked disease in California. The active organism proves to be a new species of *Pseudomonas*. The usual book reviews, minor notices and notes for students complete the number.

THE second (April) number of Volume II. of the *Transactions* of the American Mathematical Society contains the following papers: 'Canonical Forms of Quaternary Abelian Substitutions in an Arbitrary Galois Field,' by L. E. Dickson; 'Certain Cases in which the Vanishing of the Wronskian is a Sufficient Condition for Linear Dependence,' by M. Bôcher; 'An Elementary Proof of a Theorem of Sturm,' by M. Bôcher; 'On the Determination of Surfaces capable of Conformal Representation upon a Plane in such a Manner that Geodetic Lines are represented by Algebraic Curves,' by H. F. Stecker; 'On the Existence of a Minimum of Integral $\int_{x_0}^{x_1} F(x, y, y')\, dx$ when x_0 and x_1 are Conjugate Points, and the Geodesics on an Ellipsoid of Revolution; a Revision of a Theorem of Kneser's,' by W. F. Osgood; 'On the Geometry of Planes in a Parabolic Space of Four Dimensions,' by I. Stringham.

THE March number of the *Bulletin* of the American Mathematical Society contains the following papers: 'Report of the December Meeting of the Chicago Section,' by Professor T. F. Holgate; 'Indirect Circular Transformations and Mixed Groups,' by Professor H. B. Newson; 'Pure Mathematics for Engineering Students,' by Professor A. S. Hathaway; 'Review of Adams' Unpublished Papers,' by Professor E. W. Brown; 'Notice sur M. Hermite' (translation of an address before the Paris Academy of Sciences), by M. C. Jordan; 'Notes'; 'New Publications.' The April number contains the following papers: 'Report of the February Meeting of the Society,' by Professor F. N. Cole; 'Green's Functions in Space of One Dimension,' by Professor M. Bôcher; 'On a System of Plane Curves having Factorable Parallels,' by Dr. Virgil Snyder; 'Possible

Triply Asymptotic Systems of Surfaces,' by Dr. L. P. Eisenhart; 'Note on Hamilton's Determination of Irrational Numbers,' by Dr. H. E. Hawkes; 'Review of Muth's Elementartheiler,' by Mr. T. J. I'A. Bromwich; 'Shorter Notices': 'Fricke's Lectures on Higher Mathematics,' and 'Böger's Plane Geometry of Position,' by Professor H. S. White; 'Notes'; 'New Publications.'

SOCIETIES AND ACADEMIES.

SECTION OF GEOLOGY AND MINERALOGY OF THE NEW YORK ACADEMY OF SCIENCES.

AT the meeting of the Section on March 18th, the following program was presented:

'The Cambro-Ordovician Outlier at Wellstown, Hamilton County, New York.' In introducing the subject of the paper Professor Kemp gave a brief account of the physiographic problems presented in the Adirondacks and of the significance of the smaller outlines of Paleozoic strata which occur within the crystalline area. He then discussed the Wellstown exposure and described it in much the same way as he has already done in print in the 'Eighteenth Annual Report of the State Geologist of New York,' page 145. The general conclusion favored the existence of land areas of ancient crystalline rocks in the vicinity of Wells, and, it seemed to the speaker, that the peculiar sediments could not be explained in any other way. Pebbles, as large as one's fist, of gneiss similar to that found in the ancient hills, are imbedded in the Trenton limestone, and much sand is found in the limestones of both the Calciferous and the Trenton. It was admitted that the present valley is due to faulting, as has been previously claimed by Dr. R. Ruedemann, but the shores of the late Cambrian and early Ordovician could not have been far from the present outcrops of the Paleozoics at Wells. Mr. Van Ingen and Doctors Levison, Dodge, White and Julien took part in the discussion of the paper.

Dr. Julien remarked, in regard to the sand found in the limestones to which Professor Kemp referred, that although the smaller and angular portion of the sand, in which feldspar is common, and particles of garnet, epidote and menaccanite also occur, may possibly be residual, derived from decay of gneiss adjacent to the shores of the ancient basin, the predominant quartz grains, well rounded and even perfectly spherical, could not possibly be of that origin. Their sculpture indicates prolonged action during ages before they assumed spherical form, and that although found in sediments loose or consolidated in all periods from the quartzites of the Laurentian down to the present beaches along rivers, lakes and ocean, they represent in all cases ancient materials which have been worked up over and over again from period to period. In the Potsdam of the North American continent they have been accumulated in an extensive outer-beach deposit, the result of an enormous resorting of materials throughout the vast Cambrian time. These 'paleospheres' were doubtless derived from the same Potsdam horizon which has yielded the oolitic quartz sand of the 'singing beach' on the shores of Lake Champlain, near Plattsburg, not many miles from the Wellstown Ordovician outcrop. They certainly were not swept into this limestone basin by currents, since the absence of sorting and the parallel deposition of their axes show that they were dropped down from the surface in a continuous gentle shower. The conditions which favored this consist of the floating of sand from the beaches along sheltered bays, such as Long Island sound, on every quietly rising tide, with its seaward transport, often to hundreds of miles off the coast, commonly caught in the dredges of surveying steamers, as noted by Verrill and others, and in its constant subsidence over the bottom. Such sand transport was plainly in progress over the quiet embayment occupied by this limestone, from surrounding beaches supplied from the decay and disintegration of an ancient shore of Potsdam and Calciferous sandstones. The various sands referred to in these remarks were illustrated by photomicrographs.

'A Method of facilitating Photography of Fossils' was described by Mr. Gilbert Van Ingen. The process consists in forming, on the surface of the specimen to be photographed, a thin coating of ammonium chloride by the combination near that surface of ammonia gas and

hydrochloric acid gas. Such a coat effectually hides all coloration of the specimen and reflected light, and does not obliterate the finer details of the sculpture. The salt is perfectly harmless and may be readily removed by water, or by a soft brush. The paper was discussed by Professors Stevenson and Kemp, and Drs. Levison, Julien and White.

THEODORE G. WHITE,
Secretary.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE regular meeting of the New York Section of the American Chemical Society was held on Friday evening, April 5th, at the Chemists' Club, 108 West Fifty-fifth street, and over fifty members were present.

The following papers were read:

F. A. Sieker—'The Detection of Methyl Alcohol.'

A. H. Gotthelf—'The Synthesis of Alkyl Ketodihydroquinazolins from Anthranilic Acid.'

Durand Woodman—'Note on the Determination of Moisture in Coal.'

E. F. Kern—'Comparison of Methods for the Electrolytic Precipitation of Iron.'

E. F. Kern—'The Electrolytic Precipitation of Nickel and Cobalt from a double Cyanide Solution.'

In the discussion of Mr. Sieker's paper, Dr. Eccles suggested that for a method of detecting methyl alcohol depending on the production of a specific odor, he thought that which produced methyl salicylate was to be preferred as more characteristic than the one described producing formaldehyd.

Dr. Woodman's paper was an effort to ascertain more clearly the effect of oxidation in drying samples of coal according to the accepted method for determination of moisture. It appeared that the apparent loss of moisture in a stream of dry carbonic acid gas was uniformly less than when the coal was heated in contact with the air. This indicates that by the ordinary method there is a loss by oxidation in the first stages of heating, before the well-known increase of weight begins by more prolonged heating. The paper evoked considerable discussion as to whether the secondary increase of weight was due to oxidation, occlusion or to some change not yet explained. It was stated that further work was in progress with a view to clearing up some of these points.

Mr. Kern gave a very full and valuable exposition of the electrolytic methods for precipitation of iron, nickel and cobalt.

After the transaction of some miscellaneous business in connection with the twenty-fifth anniversary of the Society, the meeting was adjourned to May 10th.

DURAND WOODMAN,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 338th meeting was held on Saturday evening, April 6th, and was devoted to an address by Erwin F. Smith, on the subject of 'Bacterial Diseases of Plants,' the speaker considering in detail diseases of the cucurbits, the cabbage and the tomato, illustrating his remarks by numerous slides. These showed the entire plants and their histological structure in health and under the effects of the diseases discussed, showing in certain cases the water canals crowded with bacteria and in others the breaking down of the cell walls and the invasion of the healthy tissue by bacteria. The speaker described the physiological differences between the species treated and said that the diseases considered were mostly conveyed from plant to plant by beetles whose bites inoculated the healthy plants with bacteria derived from the diseased plants on which they had previously fed. Hence the remedy for the disease was to wage war on the beetles.

F. A. LUCAS.

THE LAS VEGAS SCIENCE CLUB.

THE regular monthly meeting of the Club was held April 9th. Mr. T. D. A. Cockerell exhibited specimens of *Sphœrium magnum* Sterki MS., found abundantly in the Pleistocene deposit of the Arroyo Pecos, Las Vegas. This species, although undescribed, was known to Dr. Sterki in the living state from Missouri, Kansas, etc.; but it had not been observed living in New Mexico. Mr. Cockerell also exhibited *Veronicella agassizi* n. sp., a slug found by Professor Alexander Agassiz in Tahiti. It was related to *V. gilsoni* of the Fiji Islands but apparently distinct. Mr. Emerson Atkins read a paper on

the 'Occurrence of the Western Evening Grosbeak (*Coccothraustes vespertinus montanus*) in Las Vegas,' and exhibited specimens of the birds. These birds had never been seen in Las Vegas, until about October 30th last, when they suddenly appeared in great numbers. They had remained in the town until the present month; Mr. R. H. Powell remarked that he had seen them as recently as April 7th. Mr. Frank Springer stated that he had observed them in Santa Fé during February. Mr. E. L. Hewett exhibited a curiously twisted stone spear-head which had been found at Chapelle, N. M. It was evidently designed to twist in the wound, and was unique among the spear-heads collected in New Mexico. Mr. Hewett also called attention to a triskelion (three-leg) design which he had seen on a piece of ancient pottery from Arizona. He also showed some of the vessels from the burial mounds of the Pajarito district, N. M., in which the same design occurred, but modified, so that what appeared to be hands, with claw-like fingers, took the place of feet.

T. D. A. C.

DISCUSSION AND CORRESPONDENCE.

PRIORITY OF PLACE AND THE METHOD OF TYPES.

IN SCIENCE for April 12, 1901, Professor N. L. Britton has given an adequate explanation and justification for the rule of nomenclature which accepts precedence of page or position as a substitute for priority in time in determining which of two or more simultaneously published synonyms shall receive permanent recognition. It is further held that the proposed use of the first species as the type of its genus is simply an extreme extension of the idea of priority of place, and all reference to the method of types as a means of securing stability in the application of generic names is omitted.

In reality the priority or precedence analogy of the method of types is quite incidental to the main argument, and has been brought forward only because it seemed likely to influence favorably those who have been zealous in advocating 'page priority.' Professor Britton very properly maintains that there is an important logical distinction between the two propositions, but he does not bring out the facts that while precedence priority is a small matter, affecting a few isolated instances, stability in the use of generic names is of universal taxonomic importance, and that the method of types * still remains the only suggested means of obtaining it. Page priority is not particularly just or reasonable, since an author's last treatment of a genus or species is likely, on the whole, to be better than the first, and a rule to take the last of the synonyms appearing in the same book would be quite as definite and as readily applicable as one requiring the use of the first. But such a policy would not be in accord with the principle of priority, and it accordingly received but little consideration when the formulation of a definite rule was undertaken. With the method of types, also, the desideratum is a uniform rule, but thus far those who object to the use of the first species have not proposed to use the last species, or any other species in particular, doubtless because they still fail to realize the taxonomic bearing of the fact that under an evolutionary view of nature a genus is no longer to be treated as a concept † or a definition, but as a group of species.

The reasons for selecting the first species as the nomenclatorial type of a genus are quite as good, to say the least, as those for accepting the first name in a book, but they appear trivial when compared with those which require the taking of *some* species as the type, and that by a definite rule of uniform application. Accordingly, it is scarcely pertinent to bring merely nomenclatorial or historical objections against the proposition to use the first species as the type, until it can be shown that the general systematic and taxonomic requirements met by the method of types can be accommodated by the use of some other than the first species.

Professor Britton's further objection to the use of the first species, that 'it would render useless for nomenclatorial purposes much original investigation through which genera have been definitely established,' must be seriously discounted, to say the least, in view of the fact that the 'original investigation' has been conducted, either without any uniform plan, or

* SCIENCE, September 28, 1900, XI., 476.

† SCIENCE, October 14, 1898, VIII., 513.

under one incapable of producing the desired uniformity. If we may trust President Jordan's frank statement of the results of his extensive experience with the method advocated by Professor Britton, "The process of elimination has never been consistently followed, nor can the process be so defined that it can yield fixed results in the case of the complex genera of the last century."*

Instead of supplying an argument for continuing longer on the same lines, the variety and instability inevitable under the method of elimination afford an excellent reason for seeking a more satisfactory rule of procedure. And to obtain this it is not, as Professor Britton seems to imply, necessary that 'historical types' or the expressed wishes of the authors of genera shall be disregarded. Those who are interested in the possibility of such improvements should, however, consider the several steps in the order of their importance and cease to make confusion between the taxonomic principles and the merely nomenclatorial incidents of the process.

The first essential of systematic biology is a convenient and stable taxonomy.

A satisfactory degree of convenience was attained over a century ago by the adoption of the binomial system, involving the joint recognition of generic and specific names.

Stability can be secured by the uniform use of the oldest names applied under the binomial system of nomenclature.

Generic and specific names have nomenclatorial standing when they have been used as parts of binomials.

Priority requires that a species shall bear the oldest name applied to it, and, conversely, that a specific name shall be used only for the first species to which it was applied.

Effective priority or stability in the application of a generic name can be attained by restricting its use to the congeners of the first species to which it was applied as part of a binomial.

All such principles and methods have, however, their logical and practical limitations and exceptions, but it is quite illogical and unpractical to ignore or set aside a more important for a less important consideration. It is essential that we have some one species permanently designated as the nomenclatorial type of each genus, but it is not essential that it be the first species, and there are good reasons for admitting two exceptions, not of the method of types, but of this suggestion for its nomenclatorial application.

Exception 1.—Describers of genera may designate their type species in the papers in which their generic names are published.

Exception 2.—Generic names adopted into binomial nomenclature from older writings should be used in their original application. It is not, however, desirable or expedient that such restorations be carried in botanical literature farther back than Tournefort's 'Institutiones' (1700).

The first provision enables us to conserve such parts of systematic literature as can be readily adjusted to present ideals and methods, while the second avoids too abrupt a break between the binomial and the prebinomial literature of botany, and at the same time obviates the principal objection to 1753 as the initial date for botanical nomenclature.

Until an equally practicable alternative proposition is brought forward, the use of the first species as generic type should receive the support due to the idea of stability in biological taxonomy, whether the above exceptions be admitted or not. The exceptions do not, however, militate in any sense against the principles involved, and will but slightly increase the labor of applying the method of types. It is accordingly to be hoped that they will be deemed a sufficient concession by those who have approached biological studies from the traditional and historical standpoints, but who are still able to realize the difference between a rule of nomenclature and a primary requisite of biological taxonomy.

O. F. Cook.

Washington, D. C., April 15, 1901.

* Science, November 23, 1900, XII., 786.

THE PROPER NAME OF THE ALPINE CHOUGH.

To the Editor of Science: My suggestion in a recent number of Science (N. S. Vol. XIII., p. 232) that the name of the alpine chough should stand as *Monedula pyrrhocorax* L. (Hass),

in view of Hasselquist's use of the name in 1762, for the *Upupa pyrrhocorax* Linné (1758), which latter name was changed to *Corvus pyrrhocorax* by Linné in 1766, Hasselquist's name therefore having priority over the latter one by four years. Hasselquist's name having appeared first in 1757, and later in a German translation of his work,* Mr. P. S. Sclater (SCIENCE, N. S. Vol. XIII., p. 626) thinks the name should not stand, as it was first described prior to 1758, and after that date only in a translation of Hasselquist's work. If Mr. Sclater's view be adopted, will it not be necessary to exclude many names occurring in the 10th and 12th editions of the *Systema Naturæ*, because they were originally described in earlier editions of that work?

Whether the alpine chough occurs in 'Lower Egypt' or not has in my opinion little bearing on the matter. The question is, is *Monedula pyrrhocorax* Hass, the same as *Upupa* (=*Corvus*) *pyrrhocorax* Linné; and we have Linné, who personally examined Hasselquist's collections, as an authority in the affirmative.

WILLIAM J. FOX.

THE ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, PA.

* 'Iter Palæstinum,' etc., 1762.

BOTANICAL NOTES.

THE STUDY OF MOSSES.

DR. A. J. GROUT, of the Brooklyn Boys' High School, has made the study of mosses much easier by the publication of a very pretty little book, entitled 'Mosses with a Hand-Lens,' and two sets of dried and carefully prepared specimens under the titles of 'North American Musci Pleurocarpi' and 'Hand-lens Mosses.' The book is a thin octavo volume of about seventy-five pages, and is a non-technical handbook of the more common and more easily recognized mosses of the North-eastern United States. It is illustrated by helpful figures, which, if not as smoothly engraved as some to be found in recent text-books, have the merit of clearly showing what they are intended to show. The descriptions are, as indicated above, non-technical, but they will perhaps prove all the more helpful to most beginners on that account. In all, one hundred species are noticed. The volume closes with an appropriate glossary of bryological terms and a brief index. The first collection of specimens will enable the beginner to recognize the genera and species represented, although this was not the use which Dr. Grout had in mind in their preparation. They were designed rather for the benefit of the professional bryologist, but they will serve the beginner as well, since they illustrate the plants and their fruits. The second collection, which is just now appearing, was evidently suggested by the use here indicated. It consists of similar specimens, carefully selected and supplied with neat printed labels.

BOTANICAL FACILITIES AFFORDED TO STUDENTS BY THE NEW YORK BOTANICAL GARDEN.

IT is probably not generally known to what extent the rich treasures of the New York Botanical Garden are available to students of the several phases of botany. Although the institution is in the first lustrum of its existence, it inherited the collections of books and specimens left by Dr. Torrey after a long life of accumulative activity. There are thus nearly one million specimens in the herbarium and about nine thousand volumes in the library. Added to these are the native plants growing in the woodlands, meadows and swamps of the two hundred and fifty acres of land constituting the domain of the Garden, supplemented by the plantations of herbaceous and woody vegetation, and the already large collections under glass in the great Plant House. The laboratories, of which there are physiological, embryological, chemical, morphological and taxonomic, are housed in the fine building known as the 'Museum Building.' They occupy a suite of fourteen rooms on the upper floor of the building, and are admirably planned for the several lines of work to be done in them. From a recent statement by the director we learn that opportunities are afforded for work in the following subjects: Physiology of the cell, ecology, morphology of algae, morphology of fungi, morphology of bryophyta, morphology of pteridophyta, morphology of spermatophyta, experimental morphology, taxonomy of algae, tax-

onomy of fungi, taxonomy of bryophyta, taxonomy of pteridophyta, taxonomy of spermatophyta, taxonomy of gramineae, embryology of spermatophyta, special taxonomy, regional botany, physiology of nutrition, ecological physiology, physiological anatomy, general physiology. The director says further, "Almost any problem in botany may be taken up by the trained botanist, who may come to the laboratories with the expectation of finding facilities for his work." It should be borne in mind that 'the laboratories never close for a vacation,' and that one may work here when most universities are closed.

A STUDY OF WHEAT.

MR. M. A. CARLTON, of the Division of Vegetable Physiology and Pathology of the United States Department of Agriculture, has for several years been engaged in a study of wheat with especial reference to its growth in different portions of this country. He finds that the country may be divided into eight wheat districts, as follows: (1) The soft wheat district, including mainly the north Atlantic states (in Virginia the mountainous region only); (2) the semi-hard winter wheat district, including the north central states; (3) the southern wheat district, including the northern part of the southern states; (4) the hard spring wheat district, including the states of the northern Plains; (5) the hard winter wheat district, including the states of the middle Plains; (6) the durum wheat district including a part of the states of the southern Plains; (7) the irrigated wheat district, in scattered areas in the Rocky Mountains and the Great Basin; (8) the white wheat district, including the larger part of the Pacific Coast states. A colored map illustrates these divisions in the bulletin (No. 24) in which Mr. Carlton discusses this subject. The species and sub-species of wheat recognized by Mr. Carlton are in the main those accepted by Koernicke and Werner in their 'Handbuch des Getreidebaues' as follows:

Triticum vulgare, the most valuable and widely distributed species, represented by a greater number of varieties than all other species taken together, including the soft winter wheats, hard winter wheats, hard spring wheats, white wheats and early wheats: *Triticum compactum*, more properly a variety of the former, including the club sheets.

Triticum turgidum, a subspecies of *T. vulgare*, including the Poulard wheats, with such varieties as 'Seven-headed Wonder,' 'Hundred-fold' and 'Miracle.'

Triticum durum, a subspecies of *T. vulgare*, including the durum or macaroni wheats.

Triticum polonicum, a distinct species, including the Polish wheats.

Triticum spelta, a subspecies of *T. vulgare*, including spelt.

Triticum dicoccum, a subspecies of *T. vulgare*, including spelt-like wheats bearing the German name of 'Emmer.'

Triticum monococcum, a very distinct species, practically unknown in America, and but little grown in Europe, where it bears the German name of 'Einkorn.' It is said to be 'rust proof.'

In discussing the problem of the best varieties for this country the author says that, "considering all qualities, the best wheats in the world are of Russian origin, coming particularly from eastern and southern Russia. They are resistant to cold and drought, and are more or less resistant to leaf rust, and have the best quality of grain." Considerable space is given in the bulletin to the discussion of the means for the improvement of wheat aside from the mere introduction of valuable varieties. This is brought about by selection, and hybridization or 'breeding.' Examples of the latter are shown in a colored plate. The paper closes with a summary which contains many valuable practical suggestions.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

SCIENTIFIC NOTES AND NEWS.

THE officers of the International Association of Academies, which met last month at Paris, are as follows: *Honorary Presidents*, Dr. Mommsen, M. de Goeje, Sir Michael Foster, M. Berthelot, and M. Gaston Boissier; *Acting President*, M. Darboux; *Vice-President*, Dr. Diels; *Secretaries*, MM. Gomperz and Moissan. M. Darboux made an address of welcome, but otherwise the scientific work of the meeting has not been made public. We regret to learn that Professor G. L. Goodale, delegate from the National Academy of Sciences, was unable to

be present, having been detained at Geneva by illness.

Mr. Herbert Spencer celebrated his eighty-first birthday on April 27th. Mr. Spencer lives quietly at Brighton. His health is fair, but he is not able to undertake much literary work.

The Manchester Literary and Philosophical Society has awarded the Wilde gold medal to Dr. Metchnikoff, of the Pasteur Institute in Paris. The presentation was made at a meeting of the Society on April 22d, when Professor Metchnikoff delivered an address on the 'Bacterial Flora of the Intestine.'

The King of Sweden has conferred on Professor J. H. Gore, of Columbian University, Knighthood of the Order of Wasa, in view of his services as a member of the Superior Jury and Committee of Five at the Paris Exposition.

Professor Charles Howard Hinton, of the University of Minnesota, has recently been appointed a computer at the U. S. Naval Observatory in Washington.

The U. S. Department of Agriculture is about to establish an agricultural experiment station in Porto Rico, which will be under the direction of Mr. Frank D. Gardner, now of the Division of Soils.

Dr. Harlow Brooks, instructor in the University and Bellevue Hospital Medical College, has been appointed pathologist to the New York Zoological Park.

The corporation of Hull (Yorkshire, England) has recently taken over the Museum of the Literary and Philosophical Society in that town, and has appointed Mr. T. Sheppard as curator.

Mr. O. P. Austin, chief of the Bureau of Statistics of the Treasury Department, has gone abroad to study the statistical work of other nations.

Dr. Cornelia L. Clapp, professor of zoology at Mt. Holyoke College, has been given a year's leave of absence which she will spend in study at Naples.

Dr. B. T. Galloway, director of the Bureau of Plant Industry, has been placed in charge of the seed distribution from the Department of Agriculture.

Dr. Tarleton H. Bean, who was superintendent of the New York Aquarium prior to April 1, 1898, was deprived of this position by the abolition of the office. A new position, entitled 'Superintendent of Small Parks,' was shortly afterwards created, and its incumbent was given charge of the Aquarium. Dr. Bean brought suit against the City for re-instatement, as he could not be legally discharged, and the office being abolished appeared to be a subterfuge. The Court has, however, now decided this suit in favor of the City authorities.

The erection of a memorial to the late Right Hon. Professor T. H. Huxley in Ealing, near London, where he was born and received his early education, is contemplated. On the initiative of the Council of the Ealing Natural Science Society, a committee of those connected with the district who are interested in the project has been formed. The first meeting of this Committee was held on 29th of March last, when an executive committee was appointed (whose chairman is the Rev. Professor G. Henslow, Pres. Ealing Nat. Sci. Soc.). A bronze medallion portrait has been advocated for the central feature of the design, which may take the form of a simple mural tablet or of a more worthy monument as funds are obtainable, while should that support be forthcoming for which its projectors hope an annual grant or medal might also be founded. Subscription to the fund is not confined to the neighborhood or land of Huxley's birth, and those who may be desirous of assisting in the endeavor to keep green the memory of the great scientist in his natal town should communicate with the secretary to the fund, Mr. B. B. Woodward (120 The Grove, Ealing, London, W.).

Professor F. M. Raoult, the eminent chemist, known for his important researches on the lowering of the freezing point and lowering the vapor tension of solvents by dissolved substances, has died at Grenoble at the age of seventy-one years.

Dr. William H. Draper, emeritus professor of clinical medicine in the College of Physicians and Surgeons, Columbia University, and one of the trustees of the University, died on April 26th, at the age of seventy years.

MR. E. S. NETTLETON, connected with the Department of Agriculture as an expert on irrigation, died at Denver on April 22d, at the age of sixty-nine years.

SHORTLY before the lamented death of Professor H. A. Rowland, his mechanician in the Physical Laboratory of the Johns Hopkins University, Mr. Theodore C. Schneider, died. He had been connected with the Laboratory ever since the founding of the University. Under Professor Rowland's personal supervision, he constructed the three machines used for ruling the spectrum gratings made at this laboratory and used in all parts of the world where exact measurements in spectroscopy are attempted; and for several years he has had exclusive charge of selecting and of adjusting the diamond points to the machine, and of ruling the gratings. The construction of these ruling machines involved the grinding of screws a foot or more in length, which should be as perfect as possible throughout their lengths. Mr. Schneider ground four of these screws which under the most severe tests to which they can be put have as yet shown no appreciable error. They are without doubt the most perfect screws in the world.

DR. GUILIO BIZZOZERO, professor of general pathology in the University of Turin, died on April 8th at the age of fifty-five years. He was the author of numerous important papers on changes in minute anatomy produced by disease and, more recently, on State medicine.

M. PAUL CHAIX, for many years professor of geography in the University of Geneva, has died at the advanced age of ninety-three years. He had traveled much and was the author of various works on geography.

WE also regret to announce the death of Dr. John Kloos, professor of geology and mineralogy in the Technical Institute at Braunschweig, at the age of fifty-eight years; and of Dr. Daniel Wierzbicki, astronomer in the observatory at Cracow, at the age of sixty-eight years.

THE first *conversazione* of the Royal Society will take place on Wednesday, May 8th.

THE Government of Norway and Sweden has called a conference of representatives of countries interested in marine exploration to meet in Christiania in May. Germany, Great Britain, Denmark, Holland and Russia, besides Norway and Sweden, have indicated their intention to send delegates, and it is expected that other countries will be represented.

A TELEGRAM was received at the Harvard College Observatory, on April 26th, from Professor Kreutz, at Kiel Observatory, stating that a very bright comet, discovered by Halle at Queenstown, April 23d, was observed at Capetown by Gill, April 24d.712, Greenwich mean time in R. A. 1h. 30m. 4s. and Dec. + 3° 27′. The comet was observed by Professor E. B. Frost at the Yerkes Observatory on the 27th, just before sunrise and close to the sun.

GOVERNOR ODELL has signed the bill which permits New York City to accept the $5,200,000 gift of Mr. Andrew Carnegie for a free library system. The bill was drawn by Corporation Counsel Whalen and authorizes the city to purchase, erect and maintain libraries, and to enter into a contract with Mr. Carnegie to accept his gift under the conditions named by him.

THE workshop for the grinding of lenses and construction of telescopes, established by Mr. Alvan Clark, which was purchased from the heirs by one of his daughters, Mrs. William H. Grogan, Jr., and conducted by Mr. Grogan until his death last July, has been sold to the Alvan Clark and Company corporation.

BEGINNING on about the fifteenth of May, 1901, the Biological Department of the University of California will commence a systematic biological survey of the coast of that State. Temporary headquarters are established at San Pedro, and the work for the first summer will be carried south from Pt. Conception toward San Diego. A gasoline launch, which has been obtained for the season, will be fitted out with apparatus for dredging, sounding and making observations on temperature, salinity, specific gravity, etc. The work will be carried on by the members of the Department and graduate students, together with a number of investigators who have already interested themselves especially in west coast faunas. The funds to be used in the work were raised by Mr. W. H. O'Melveny, a graduate of the University, among the citizens of Los Angeles.

THE Mining School of McGill University will this year carry on its summer work in British Columbia. The class expected to leave Montreal by special car on the Canadian Pacific Railway on May 1st, and to go out to the Pacific coast, visiting the various collieries along the line of the railway and on Vancouver Island. The party will then go into southern British Columbia for the purpose of studying the mineral deposits of the Slocan, Trail Creek and Boundary Districts, and, returning by the Crows' Nest Pass route, will visit the coal mines at Fernie Hethbridge, reaching Montreal again about the middle of June.

THE daily papers state that a party of students from Harvard University will undertake, this summer, an expedition to Venezuela for botanical and zoological research. They are to leave New York on the steamer *Caracas*, on June 15th, and will proceed to La Guayra and Margarita Island.

THE assignment of field parties by the U. S. Geological Survey for the present season are as follows: Arizona: T. A. Jaggar, Waldemar Lindgren, J. M. Boutwell, F. L. Ransome, John D. Irving and R. T. Hill; Arkansas: George I. Adams; California: George F. Becker, W. Lindgren, J. C. Branner, J. S. Diller, Geo. H. Eldridge and H. W. Turner; Colorado: C. W. Cross, Ernest Howe, J. Morgan Clements, S. F. Emmons, John D. Irving and George I. Adams; Connecticut: William H. Hobbs and H. E. Gregory; Delaware: R. D. Salisbury and George B. Shattuck; Georgia: Arthur Keith; Idaho: Bailey Willis; Indiana: George H. Ashley; Indian Territory: J. A. Taff and George I. Adams; Kansas: W. S. Tangier-Smith; Kentucky: M. R. Campbell and George H. Ashley; Louisiana: George I. Adams; Maryland: Continuation of cooperative work as in previous years, William B. Clark, E. B. Matthews and George B. Shattuck, study of ancient crystalline rocks, paleozoic stratigraphy and coastal plain deposits; Massachusetts: B. K. Emerson; Michigan: Frank Leverett, F. B. Taylor, C. R. Van Hise, C. K. Leith and W. S. Bayley; Minnesota: C. R. Van Hise and J. Morgan Clements; Missouri: W. S. Tangier-Smith; Montana: Continuation of special studies in the Rocky Mountains, Charles D. Walcott, director; W. E. Weed and Bailey Willis; Nevada: G. K. Gilbert; New Jersey: R. D. Salisbury and George B. Shattuck; New Mexico: George H. Girty, R. T. Hill and C. W. Cross; New York: L. C. Glenn, T. N. Dale and J. F. Kemp; North Carolina: Arthur Keith; North Dakota: N. H. Darton and C. M. Hall; Ohio: Charles S. Prosser; Oklahoma: J. A. Taff; Oregon: J. S. Diller; Pennsylvania: Parts of Butler, Armstrong, Indiana, Washington, Westmoreland, Fayette and Tioga counties, M. R. Campbell, A. C. Spencer, George B. Richardson and L. Fuller; northern Pennsylvania: George H. Girty; Philadelphia and vicinity, Professor Florence Bascom and C. R. Van Hise; refractory clays of Pennsylvania, C. W. Hayes; Fulton and Franklin counties, George W. Stone; coal measures, C. D. White; South Carolina: Arthur Keith; South Dakota: N. H. Darton and J. E. Todd; Tennessee: Arthur Keith; Texas, R. T. Hill and George I. Adams; Utah: C. K. Gilbert; Vermont: T. N. Dale and J. E. Wolff; Washington: F. L. Ransome and Geo. Otis Smith; West Virginia: Cooperation with State survey under Professor I. C. White; Wayne county: M. R. Campbell, survey of Ceredo quadrangle; Wisconsin: C. R. Van Hise and W. C. Alden; Wyoming: W. C. Knight, N. H. Darton, George I. Adams and Arnold Hague.

THE correspondent from India of the London *Lancet*, writes under date of March 28th: "Plague has caused 11,560 deaths throughout India during the past week. The mortality is increasing with alarming rapidity in the Lower Provinces. Of the above total, no fewer than 7,315 deaths occurred in the Bengal districts. In Calcutta there were 1,040 deaths. The plague cases reported in this city were 1,199 against 993 during the previous week and the number of fresh living cases seen was 345. Disinfection continues to be extensively practiced, not only in respect of the rooms and houses where the cases occur, but in many of the adjoining houses. The process adopted consists in flushing the floors and spraying the walls with the standard solution of perchloride of mercury. Cases continue to occur in

the disinfected quarters, and it is impossible to show that the measure possesses much value. The outbreak in Calcutta now is more severe than that of last year, notwithstanding the repeated disinfections which have been practiced. As I have before remarked, however, the authorities are apparently able to account for nearly all the plague deaths and the investigations made after death indicate the exact location of the cases. The reported plague deaths in Calcutta nearly account for the excess mortality, and that is more than can be said for any other city. The disease is spreading in Benares and has reached to the cantonment. It continues to progress from village to village in the Gardaspur and Sialkot districts of the Punjab. In Bombay city plague has caused over 1,000 deaths during the past week. An examination of the total deaths in this city since the plague appeared in 1896, shows an excess mortality over the average of 120,000. The official reports only give 60,000 deaths from plague since its commencement in September, 1896, so that there is a very large balance to be accounted for. If the system adopted in Calcutta had been applied to Bombay, it is most probable that the greater part of this excess would have been found to be due to plague, and it is almost safe to say that Bombay city has lost 100,000 of its inhabitants from plague."

Nature learns from the *Victorian Naturalist* that Professor Spencer, F.R.S., of the Melbourne University, and Mr. F. J. Gillen, of South Australia, were expected to start from Oodnadatta, the present terminus of the transcontinental railway, nearly 700 miles north of Adelaide, on their expedition for the purpose of studying the habits and customs of the aboriginals of the northern portion of Central Australia, about the middle of April. The start has been somewhat delayed owing to the drought which has existed for some time in the portion of the continent to be visited. It is also proposed to cross into Queensland and continue Dr. Roth's ethnological work, and afterwards to traverse some of the larger rivers of the Northern Territory, and, if time permit, to visit the Wyndham district on Cambridge Gulf in Northwest Australia.

AN Institute for Tropical Hygiene was opened in Hamburg at the beginning of March. According to the *British Medical Journal*, it is a combination of laboratory and hospital, and the scientific workers in the first department will be able to find their material 'on the premises,' so to speak. The building has been erected close by the harbor; one wing contains 50 beds for tropical cases, such as malaria, beri-beri, etc. (not for infectious diseases); the second wing is taken up by the laboratories, lecture halls, etc. Here courses of lectures, combined with practical work, are to be held for the benefit of ship surgeons, navy surgeons, doctors about to settle in the colonies, and colonial medical officers of the State. The Institute has been erected by and belongs to the Free State of Hamburg, but the German Empire contributes a share of the working expenses, and the disposal of a certain number of laboratory places.

AT the last monthly general meeting of the Zoological Society of London, it was stated that there had been 106 additions to the Society's menagerie during the month of March, amongst which special attention was directed to the male Tasmanian wolf (*Thylacinus cynocephalus*), seldom seen in captivity, and also to the Indian birds presented by Mr. E. W. Harper, of Calcutta, new to the Society's series. It was also stated that on Easter Monday the admissions to the Society's gardens were 46,599, being a larger number than had ever passed the gates in one day since the opening of the gardens to the public in 1828. At the close of the general meeting the first of the annual series of lectures was delivered by Professor Charles Stewart, entitled 'On the Protection and Nourishment of Young Fishes.'

UNIVERSITY AND EDUCATIONAL NEWS.

AT a recent meeting of the regents of the University of Kansas, arrangements were made for the expenditure of the $10,000 appropriated by the Legislature, for improvements in the new chemistry building, and it was also decided to purchase a liquid-air plant. $7,000 will be